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CANADIAN THESES ON MICROFICHE

THÈSES CANADIENNES SUR MICROFICHE

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TITLE OF THESIS/*TITRE DE LA THÈSE* THE RELATION OF ACADEMIC PERFORMANCE TO STRATEGY TRAINING AND REMEDIAL TECHNIQUES: AN INFORMATION PROCESSING APPROACH

UNIVERSITY/*UNIVERSITÉ* UNIV. OF ALBERTA

DEGREE FOR WHICH THESIS WAS PRESENTED/ *GRADE POUR LEQUEL CETTE THÈSE FUT PRÉSENTÉE* PH.D

YEAR THIS DEGREE CONFERRED/*ANNÉE D'OBTENTION DE CE GRADE* 1978

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THE RELATION OF ACADEMIC PERFORMANCE TO STRATEGY TRAINING AND REMEDIAL TECHNIQUES: AN INFORMATION PROCESSING APPROACH

by

© DAVID KAUFMAN

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE
OF PH.D.

IN

SPECIAL EDUCATION

DEPARTMENT EDUCATIONAL PSYCHOLOGY

EDMONTON, ALBERTA

SPRING, 1978

√

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled THE RELATION OF ACADEMIC PERFORMANCE TO STRATEGY TRAINING AND REMEDIAL TECHNIQUES: AN INFORMATION PROCESSING APPROACH submitted by DAVID KAUFMAN in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Special Education.

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ABSTRACT

Relationship between strategy training, within a successive-simultaneous processing model, and academic performance was explored in the present study. The purpose of this study was to determine the extent to which strategy training may lead to better performance in successive and simultaneous processing, and to improved performance in some academic tasks such as reading and arithmetic.

A battery of tests requiring successive and simultaneous processing was administered to 68 Grade 4 children with varying levels of academic performance. Scores were factor analyzed. The two factors, successive and simultaneous, could be identified clearly.

On the basis of Metropolitan Achievement Test (MAT), a measure of academic performance, the children were divided into "Average" and "Below Average" groups. Children within these two groups were randomly assigned to either the Experimental group which received training or the Control group. Each student in the Experimental group received 10 hours of training, after initial testing, on an individual basis over a 17 week period; the Control group received no intervention. Interventional training consisted of teaching the use of successive and, where the task demanded, a mixture of successive and simultaneous strategies. A major part of intervention was teaching the child to verbalize his actions, such that during each session, the child was

encouraged to verbalize the strategies he used and to give a verbal summary.

Intervention not only resulted in improved performance on successive and to a certain extent on simultaneous tasks, but, more importantly, in improved academic performance in word recognition and mathematics. Detailed analyses of the results lead to the following conclusions: (i) Significant pre/post improvement occurred in the following marker tests: Memory For Designs, Serial Recall, Free Recall, Digit Span-Forward, Color Naming, and Bender Gestalt; (ii) Word attack skills, as measured by Schonell Graded Word List, were strengthened by intervention training; (iii) Significant pre/post improvement was noted on the following MAT subtests: "Mathematics Computation," "Mathematics Concepts," and "Mathematics Composite;" and (iv) It could be statistically established that the tasks used in intervention training did result in the use of primarily successive strategies.

ACKNOWLEDGMENTS

In an extremely subjective manner, the author wishes to make the following acknowledgments:

(i) To my supervisor, Dr. J.P. Das, for his continued understanding and patience through all stages of my mental development;

(ii) To my wife, Tricia, words truly can not express her degree of loving patience, understanding and assistance in making my dream our reality;

(iii) To my sons, Scott and Shane, who never quite understood why their Daddy "never worked, but only studied books," for their bionic love;

(iv) To my parents, for maintaining an ecstatic atmosphere of love at each stage of my life;

(v) To Dr. H. Zingle, Dr. J. Goldberg, and Dr. L. Gue, for their personal and academic support;

(vi) To Dr. A. Tymchuk, for travelling many miles and providing me with the supportive base from which to "begin";

(vii) To the teachers and principals of the Canadian Armed Forces Schools, Edmonton, for allowing me to disrupt classroom activities, with particular thanks to Audrey Camplin for her assistance in the initial stages of this study;

(viii) To Dr. S. Hunka and Dr. T. McGuire, for their ability to resolve my statistical problems;

(ix) To Mr. J. Anderson, for his unscheduled individualized course in computer programming; and

(x) To Dr. D. Gibson, for providing me with the impetus to change academic disciplines, and more importantly, providing personal and meaningful assistance whenever asked.

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CHAPTER I

INTRODUCTION

Contemporary focus in the area of learning disabilities has been on the behavioral characteristics of disabled children rather than on the etiology of the disability (Black, 1974). This orientation takes into account the fact that while behaviors can be changed, causes such as brain damage cannot be altered. Similarly, factors which may be assumed to cause learning disabilities in some children have not resulted in any learning difficulty in others (Bibace and Hancock, 1969; Daveau, 1958). What has been determined is that behavioral characteristics of learning disabled children are very similar, regardless of the etiology of the disability (Meyers and Hammell, 1976; Sartain, 1976). Consequently, inadequate academic functioning has been related to many faulty behavior patterns, such as visual-motor deficiencies, auditory-motor deficiencies, cross-modal deficiencies, deficiencies in conceptual and abstract thinking, and/or linguistic and communicative deficiencies.

Many diagnostic assessment devices have been developed in an attempt to identify learning difficulties. Frostig's Developmental Test of Visual Perception and the Illinois Test of Psycholinguistic Abilities are two of the tests frequently used to identify and scrutinize the nature of learning difficulties. Recent critiques of these tests by Hamill and Wiederholt (1973) and Sedlak and Weener (1973) have indicated inherent weaknesses related to validity and reliability. Thus, it would appear that either these and other devices should be reformulated in order to provide a greater degree of reliability and validity, or new instruments with demonstrated validity and reliability should be developed.

In the attempt to ameliorate learning difficulties, many remedial programs have been developed, each having a specific emphasis. However, despite the mass of methods, materials and programs which are available, the results of many remedial interventions have not fulfilled the expectations of those involved (Meyers and Hammell, 1976; Silberberg, Iversen, and Goins, 1973). The blame for a lack of significant improvement has frequently been placed on the choice of remedial method (Silberberg _et al_., 1973). However, studies which have compared various remedial methods have yielded findings to the contrary. For example, in a study which compared the visual, auditory-phonic, and kinesthetic approaches of remedial reading for third graders, Silberberg _et al_. (1973) have concluded that while all the attempted remedial methods had drastically improved reading levels, no one method was significantly more effective in improving the children's reading level than any other method. In addition, by the middle of Grade four, the remedial gains from each of the methods had "washed-out." In another study, Belmont, Flegenheimer, and Birch (1973), using high-risk poor readers from the first grade, have compared remedial instruction using letters and words to a perceptual training approach. Each of the remedial methods was provided in addition to regular classroom instruction. The approaches were shown to be equally effective in the degree of reading advancement.

Although research findings (DeHirsch, 1973; Goins, 1958) have demonstrated that children have two essential strategies available for the processing of information, namely, viewing a stimulus as a whole or as distinct parts, subsequent investigations have failed, for the most part, to develop programs which capitalize on the practical implications of these findings. Thus, rather than developing programs which train the child to organize and process auditory, visual, motor, and tactile stimuli either as a whole (gestalt) or as temporally sequenced parts of a whole, educators have developed an abundance of modality-specific materials which often seem to ignore the processing strategy used by the child. In other words, rather than using existing material to implement remediation which focuses on strategies of information processing, most remedial research would seem to have focussed on the type of stimulus input and concomitant response output. This research has resulted in the development of yet more material stressing the use or development of sensory skills. The present study begins to examine the feasibility and effectiveness of a framework which focuses on internal processing strategies rather than on deficient modality training.

As a result of the research findings of Das and his associates, Luria's formulations (1966a, 1966b) of successive and simultaneous processing have been extended and operationalized, thus providing a framework in which to view and subsequently evaluate successive and simultaneous strategies of learning (Das, 1973b; Das, Kirby, and Jarman, 1975; Krywaniuk and Das, 1977). Rather than focussing on the improvement of deficient skills, for example, auditory closure, which seems to be characteristic of most contemporary remedial approaches, training in successive and simultaneous processes focuses on learning and learning how to form strategies of information processing. Using children in the fourth grade, the present study focuses on the efficacy of training in the use of nonacademic strategies for information processing; the objective is to improve the academic efficiency of children.

CHAPTER II

REVIEW OF THE LITERATURE

Although the discipline of learning disabilities is in the stage of infancy when compared to for example the disciplines of learning and intelligence, interest in and involvement with children experiencing difficulties in various aspects of learning have been in evidence for many decades (Hallahan and Kauffman, 1976; Meyers and Hammill, 1976; Wallace, 1976). Wallace (1976), Larsen (1976), and Hallahan and Kauffman (1976) noted that the viewpoint of the persons using the term is an important aspect in the definition of learning disabilities. Thus, for example, the professional adhering to the medical model hypothesizes the presence of some neurological and/or psychological dysfunction in learning disabilities, while the professional adhering to the academic model focuses on assessing and remediating academic deficiencies.

The current emphasis in identification of learning disabilities de-emphasizes the need to find psychological or physiological cause for school failure, but rather focuses on inadequate achievement in school work (Larsen, 1976). Thus, Kirk and Elkins (1975) found that the majority of children identified as learning disabled in their project, involving 3000 children enrolled in 21 Child Service

Demonstration Centres in the United States, had problems in reading, arithmetic or spelling. Larsen (1976) pointed out that while a small number of children are unmistakably learning disabled and give evidence of brain dysfunction or "psychological process disorders," the majority of the children labelled as learning disabled are experiencing only mild to moderate failure in school and give no indication of brain pathology or process disorders. Similarly, Sartain (1976) noted that children with deficits in reading are commonly all labelled "reading disabled," although a greater percentage of these children are retarded in reading but not disabled. The child who is truly disabled in reading is retarded in respect to his expected capacity, but, more importantly, he also lacks the skills necessary to perform even the simplest reading tasks required of his age peers (Sartain, 1976). Seemingly, learning disabilities, reading disabilities and reading retardation are often synonymously interchanged in terms of samples, although not necessarily in terms of label definition.

It would appear that many of the children included in learning disabilities programs are academically overplaced (Ames, 1977). Ames suggested that these children are potentially good students who are placed one grade ahead of their level of maturity. She also suggested that children in the low average IQ range, i.e., IQ of 80 to 90, are often placed in learning disability classes because they cannot cope with the pace of a regular class. Ames contended that as intelligence testing becomes less acceptable, as was mentioned by Estes (1974) and elaborated by Cronbach (1975), the label "learning disability" has become more acceptable than "low intelligence." However, she pointed out that the failure to recognize the conceptual ties of learning disabilities to other areas such as retardation and educational difficulties has been another major factor in the confusion regarding the definition of learning disabilities. While the child with specific learning disabilities requires special education, many so-called learning disabled children are underachievers who could, according to Ames (1977), remain in the mainstream of education with an adapted curriculum.

Thus, different theoretical viewpoints, and a concomitant lack of any other categorical placement (Ames, 1977) have combined to produce multilabels and multidefinitions for children who demonstrate difficulties associated with learning. These same factors have also combined to confuse the figures of incidence of learning disabilities. Still other recent factors which may be important contributors to much of the confusion both in the definition of the correlates of learning disability, and in the incidence figures, are poorly defined professional roles, and the current availability of government funds for learning disability programs (Kirk and Elkins, 1975; Larsen, 1976;

Sartain, 1976). Thus, many children in learning disability programs are receiving instruction in remedial reading from professionals classified as learning disability teachers, mainly because the money is available for learning disability programs, but not for remedial reading programs (Sartain, 1976). Sartain also noted that this flexibility of classification is facilitated by the overlapping symptoms presented by children experiencing various educational disabilities of varying degrees.

Chalfant and King (1976) noted that the confusion regarding the definition of learning disabilities has resulted in the conclusion by many that it does not constitute a discrete field of study. Certainly, it has resulted in the inclusion of many differing samples in the research and literature in the area (e.g., Bateman, 1966; Gillespie, Miller, and Fielder, 1975; Lerner, 1971; McDonald, 1968; Woody, 1969). Similarly, diagnostic and remedial techniques and materials have been as diverse as the behaviors these definitions have attempted to encompass. A recent survey by Berman (1977) of the available learning disability resources and diagnostic materials revealed that very few of these materials have been shown to be unequivocally effective.

Thus, it can be seen that the area surrounding the whole idea of learning disabilities is extremely complex and is fraught with difficulties in semantics, and differing diagnostic procedures and remedial techniques. The present chapter will deal only with those aspects which are felt by the writer to be germane to the scope of the present study.

This chapter will be presented under four headings: The "Learning Disabled" Child; Remedial Approaches; Strategies of Learning; and Information Processing.

The "Learning Disabled" Child

A review of the literature (Kaufman, 1970) revealed the dissonance regarding the etiology of learning disorders in children. Causal factors have been described in terms of heredity (e.g., Clemmens, 1961; Coleman and Sandu, 1967), intracellular biochemical changes (e.g., Gaito, 1961, 1963), anatomical structures (e.g., Eccles, 1964; Hebb, 1949), brain-damage (e.g., Strauss and Lehtenen, 1947), maturational lag (e.g., Bender, 1958), critical periods (e.g., Kagan, 1966), and/or environmental impingements (e.g., Provence and Lipton, 1962). The contemporary trend in the area of learning disabilities has been to focus on the observable behaviors of children rather than on the inferred causal factors (Black, 1974). This trend is based on the realization that, although it is possible to significantly change childrens' behaviors, it is often not possible to even minimally alter the causal factor such as, for example, brain damage. Myers and Hammill (1976) have noted that while the etiology of learning disability in any child may be very difficult to determine, the behavioral characteristics of children with learning disabilities, regardless of the etiology of the disability, are very similar (also, Sartain, 1976). Also, it is frequently impossible to unequivocally determine causal factors since identical factors in two different children may be accompanied by concurrent learning difficulties in one child but by a normal learning pattern in the other. For example, although electroencephalographic (EEG) tracings from children exhibiting such behaviors as perseveration and short attention span were found to be abnormal (Daveau, 1958; Kennard, Rabinovitch, and Wexler, 1952), other researchers have found abnormal EEG tracings from children exhibiting no learning problems (Ellingson, 1954; Secunda and Finley, 1942). Similarly, Bibace and Hancock (1969) found that while low academic achievement is related to perceptual-motor weaknesses as was measured by the Kephart Perceptual-Motor Survey, there are children with gross perceptual-motor weaknesses who function very well in school.

Another relevant factor in the shift of emphasis from causal factors to observed behaviors was noted by Lloyd (1975). He stated that while the definition of causal factors may be useful, definition itself would probably have little effect on the immediate methods used to educate the child, particularly since teachers do not have the specific training needed to isolate causal factors.

It has been suggested that labelling and thus categorizing children experiencing learning problems can be considered essentially as a static means of placing the responsibility for failure upon the child rather than as a descriptive and functional means of facilitating differentiated treatment programs (Farrald and Schamber, 1973; Lloyd, 1975). Within the behavioral framework, most of the major definitions advanced in the area of learning disabilities include a discrepancy between intelligence and ease of school learning, fluctuating performance across tasks, and the absence of primary retardation or sensory handicap (Bateman and Frankel, 1972). In proposing an approach to operationalize the definitions of learning disabilities, and thus hopefully identifying the population in question, Chalfant and King (1976) reviewed the most widely used definitions. They suggested that the focus of these definitions can be encompassed by five components: (a) Task failure, which can be operationalized by teacher description of academic task failure and identification of instructional or environmental problems contributing to the problem; (b) exclusion factor, which is generally already operationalized by the referral to specialists of children with mental retardation, or sensory or physical handicaps; (c) physiological factor, which includes problems such as genetic variations or biochemical irregularities that are primarily the concern of the medical profession; (d) discrepancy component, which is characterized by extreme intra-individual differences in behavior, academic areas, or between intellectual functioning level and academic achievement level; and (e) psychological processes, which they operationalized within the framework of an information processing model. Their model includes the sensory input system and the response system but focuses on the psychological processes. On the basis of inferences regarding learning styles, abilities and disabilities made from observing behavior, they identified and defined five processes. The first process, attention, refers to "the selective narrowing or focussing on the relevant stimuli in a situation [p. 234]." Discrimination, the second process, refers to the ability to differentiate between stimuli in order to respond differently to them. The third process, memory, refers to recognition or recall of previously learned or retained material. Concept formation, the fourth process, involves the development of the ability to classify objects. The fifth process, problem solving, refers to "any activity in which prior experience is used to reorganize the components of a problem situation to achieve a designated objective [p. 239]." Each of the processes is operationalized by questions which can be directed towards the child's input or output systems. What is of interest here is that once again, the observable behaviors or characteristics of the child having learning problems are the basis for labelling or remediation. Sartain (1976) summarized the most common behavioral characteristics noted in children with learning disabilities as: "...unusually awkward, inattentive, easily distracted, easily frustrated, recklessly impulsive, overexcitable, hyperactive, hypoactive, and poor organizers of tasks. They have unusual difficulty in discriminating figure-ground relationships, copying figures and words accurately, translating thoughts from speech to writing, and recalling sequences of events when listening. In addition, they write and draw poorly, quickly forget sight vocabulary, quickly forget spellings of words, reverse letters and numbers more often than most, speak in a jerky or explosive manner, or exhibit a variety of other related symptoms [p. 491]."

Since children labelled as learning disabled have been identified primarily because of academic deficiencies (Richardson, 1966), rather than because of clearly demonstrated neurological deficits (Binger, 1966; Bloom, 1956; Krathwohl, Bloom, and Masia, 1956), a behavioral framework has generally been adopted for the basis of remedial techniques (Birch and Bortner, 1968; Frostig and Horne, 1964, 1965; Kirk, 1966; Mann, 1969; Meier, 1971; Myklebust and Boshes, 1960; Richardson, 1966; Ross, 1967). However, the scope of the most frequently noted maladaptive behaviors (Richardson, 1966; Sartain, 1976) has resulted in a proliferation of sometimes diverse remedial approaches. Rice (1970) and Michal-Smith and Morgenstern (1965) concluded that the authors' viewpoint on such related areas as learning, perception, cognition and attention have influenced the definition, diagnosis and ensuing attempted remediation of learning disabilities. Thus, while all remedial approaches have behavioral change as their objective, the definitions and concomitant diagnostic techniques leading to the different approaches result in focus on different target behaviors.

Remedial Approaches

The remedial approaches in the area of learning disabilities are many and often diverse. This section will only briefly discuss some of the more prominent approaches, e.g., perceptual-motor and psycholinguistic. For a comprehensive review of remedial approaches to learning disabilities, refer to, for example, Lerner (1971) and Meyers and Hammill (1976).

Approaches which focus on perceptual-motor development place emphasis on the development of adequate motor and visual-spatial skills. Since motor activities are the child's mode of initial interaction with his environment, adequate development of this system is viewed as crucial to all other generalizations in the higher mental processes (Kephart, 1960). Meyers and Hammill (1976), in reviewing perceptual-motor approaches, have concluded that although the viewpoints of writers in the area are often different, the remedial activities are strikingly similar. One branch of the approach deals primarily with training motor processes (e.g., Delacato, 1959, 1963; Kephart, 1960). The second branch focuses primarily on visual perceptual processes (e.g., Frostig, 1970; Getman, 1962). All of these authors contend that once the child has received adequate training in perceptual-motor areas, he can be taught to read by any of the conventional teaching methods. However, in an extensive review of the research involving perceptual motor remedial approaches since 1964, Meyers and Hammill (1976) found that the perceptual-motor approach has been relatively ineffective in facilitating readiness, cognitive or academic growth.

Another prominent approach is that emphasizing psycholinguistic training. This approach is based on the Illinois Test of Psycholinguistic Abilities (Kirk and McCarthy, 1961; Kirk, McCarthy, and Kirk, 1968) which provides for derivation of a profile of the child's communication behaviors. These behaviors are grouped into receptive, expressive or organizing abilities. While not a test of specific intellectual or academic achievement, it seeks to measure abilities assumed to be basic to academic achievement (Kirk and McCarthy, 1961). Other authors of psycholinguistic remedial systems have based their programs on the ITPA test model (e.g., Bush and Giles, 1969; Minskoff, Wiseman, and Minskoff, 1972). Hammill and Larsen (1974) reviewed the results of 39 research studies which attempted to train children in psycholinguistic skills as was measured by the ITPA. They concluded that psycholinguistic training was not successful either in training psycholinguistic skills or in improving academic achievement. A study analyzing the correlations between the ITPA subtests and reading, spelling, and arithmetic was conducted by Hammill, Parker, and Newcomer (1975). They found that only the Grammatic Closure subtest discriminated between good and poor readers, and that the correlations with the other academic areas investigated were not significant. A general failing of many of the tasks used in the research on learning disabilities is poorly established construct validity and/or reliability in samples differing from those used in standardization (Mann and Phillips, 1967).

Yet another approach to academic learning has been developed by Bereiter and Engelmann (1966). The Direct Instructional System for Teaching Arithmetic and Reading (DISTAR) is a highly structured, sequentially programed method which relies a great deal on rote memory and operant conditioning in teaching basic academic skills. The program was initially begun as a means of teaching specific language skills to culturally deprived children. However, Hallahan and Kauffman (1976) have suggested the amenability of the approach in other areas, including learning disabilities. Conversely, Meyers and Hammill (1976) suggested that the program does not train the processes which underlie reading. Rather, it focuses on teaching the skills of reading to children not having severe reading disorders. The program does appear to focus on the TEACHING METHOD rather than the LEARNING STRATEGIES. A review of the current literature in the area of learning strategies by the Air Force Human Resources Laboratory (AFHRL) (1974) contended that such focus on teaching may result in the development of inappropriate learning strategies which are not transferable. A focus on rote memorization results in the child's having accumulated knowledge which is not meaningfully integrated. Thus, in not teaching learning strategies, this method discourages the child from developing an awareness of his ability to develop new strategies of learning.

Strategies of Learning

The Air Force Human Resources Laboratory (1974) defined strategies as "...ways of selecting, storing, manipulating, managing, and outputting information, [which] occur at all levels of behavior [p. 11]." In order to learn, an individual has to be able to memorize information such that responses to a task are changed as a result of either previous experience with the same task or previous relevant experience. Thus, the individual must actively transform incoming information into organized hierarchies (Inhelder and Piaget, 1964). Grouping, categorization, and linguistic meaningfulness are effective means of organizing material for recall in normal subjects (Ring, 1976). The development and use of efficient learning and mnemonic strategies has been shown to change qualitatively with age such that the active systematic manipulation of data, which facilitates memory and thus enhances performance efficiency, is not as highly developed in young children as in older children, nor as highly developed in children as in adults (e.g., Bernbach, 1967; Bortner and Birch, 1970; Hanes, 1973; Lang, 1975; Levie, 1973; Mandler and Stephens, 1967; Masur, McIntyre, and Flavell, 1973; Neimark, Slotnick, and Ulrich, 1971; Nelson, 1969; Rosner, 1971; Williams, Blumberg, and Williams, 1970).

Torgeson (1977) has pointed out that research in the area of learning disabilities often fails to differentiate between lack of performance and lack of ability. In other words, the child who does not perform well on a task purporting to measure an underlying basic ability is assumed to lack that ability (e.g., Wedell, 1970). Torgeson argued that, rather, the child may be inefficiently applying that ability. This argument gains support when one reviews some of the developmental theories within the area of learning. Reese (1962) suggested that instruction in the use of verbal mediation may facilitate learning in children who have not yet learned to use this strategy. He outlined a "mediational deficiency hypothesis" which contends that "there is a stage of development in which verbal responses do not serve as mediators [p. 502]." Presumably, within this hypothesis, training in the use of mediators would not facilitate performance. Conversely, the "production deficiency hypothesis" (Flavell, Beach, and Chinsky, 1966) states that there is a stage in development where a child does not spontaneously use mediation strategies, although these strategies are available to him. However, when given instructions to use these strategies, task performance is greatly facilitated. This view was supported by Bortner and Birch (1970) who recognized that performance is not necessarily a reflection of cognitive capacity and that performance can be altered by, for example, changes in procedure of training, in organization of the task, and in motivation.

There has been considerable research concentrating on the development of organization of material for recall in children. Much of this research has been based on the developmental theories put forth by Piaget. For example, Annett (1959) found that contiguity or complementary responses (i.e., items grouped naturally in time and space, e.g., pencil and paper) were predominant from ages 6 to 8, while similarity responses (i.e., items grouped on the basis of some common characteristic) were predominant from ages 9 to 11. Similarly, Kagan, Moss, and Sigel (1963) found that relational or complementary responses were predominant during the first three grades, but that the proportion of relational responses decreased and the proportion of similarity responses increased in later grades. Moely, Olson, Halwes, and Flavell (1969) in testing the production deficiency hypothesis found that spontaneous category clustering increased sharply between grades three and five. Bingham-Newman and Hooper (1974) found that training nursery school children in manipulation of sequentially differing material facilitated performance on post-test tasks, while training in manipulation of classification materials had little effect on post-test performance.

Lange (1973), Moely et al. (1969), and Reigel, Taylor, and Danner (1973) found that when children were directed to group according to category inclusion, recall was much superior to that of children not directed to use this strategy. However, Scribner and Cole (1972) found that although young children could make use of categories in organizing and mediating recall at the direction of the experimenter, the children failed to transfer this strategy to similar items once direction had been removed.

Similarly, Keeny, Cannizzo, and Flavell (1967) found that Grade 1 children who were not spontaneous rehearsers could be taught to use verbal rehearsal in serial recall, with concomitantly significant increase in recall score. However, these children tended to stop rehearsal when given the opportunity to do so.

Denney (1974) argued that while the ability to organize material on the basis of similarity was available to the young child, he is under no pressure to use this method of organization until he begins his formal education. Until that time, the child is more likely to use the more "natural" complementary categorization. Denney concluded that developmental changes may not be due so much to internal organismic changes as to environmental changes which occur at fairly consistent ages. Cole, Gay, Glick, and Sharp (1971), Hagan (1971), and Moely et al. (1969) also contended that the demands of the educational system generate more organized and strategic approaches to learning in children. Similarly, Nelson (1969) stated that while the young child may actively engage in organizing input stimuli, he acquires more efficient strategies for organization as he becomes older. He suggested that age-related improvement in organization is the result of replacing idiosyncratic organization with more common methods. However, Nelson also suggested that the young child receives information passively, and that active and efficient organization occurs with age. Moely et al. (1969) presented a developmental table of the mediational responses observed in their research: (a) Verbalization of names during study (frequent even in kindergarten); (b) verbal labelling and rehearsal of names (infrequent before Grades 1-2); (c) self-testing (infrequent before Grade 3); and (d) manual clustering (infrequent prior to Grade 5). They suggested that both self-testing and manual clustering are indicative of an active learner who organizes his own input rather than reacting to the input as it is given. Thus, as Torgeson (1977) stated, cognitive processes are now being considered as being dependent upon the child's active application of appropriate skills as well as upon the child's biological make-up and development.

This view was extended into the area of learning disabilities by Torgeson (1977). He suggested that the learning disabled child has not learned to become an active participant in his own learning. Thus, this child may not be aware that he can and should develop efficient learning strategies. Until the child enters school, learning is generally incidental based on concrete and natural relationships within his experience. However, once the child is in school, he is expected to learn material for later efficient recall. Thus, the child must learn to associate and organize material which is often presented in ways which, to him, are unrelated and are outside his previous experience. The learning disabled child may not have learned to do this. Torgeson suggested that these children may be more dependent on others in intellectual activities. They may not have had to learn to organize, to follow instructions, or to complete tasks in early years. Similarly, McDonald and Soeffling (1971) noted that learning problems may be a result of early linguistic and physical environments, as well as to family dynamics.

Klausmeir and Meinke (1968) and Lawson (1977) concluded that providing the individual with information about a principle facilitates learning how to learn. Klausmeir and Meinke (1968) emphasized the need to give students the principles involved in attaining and using information as well as the need to teach students how to organize material. However, DiVesta and Walls (1968) noted that learning to learn involves not only learning specific concepts, but also learning how to form those concepts. Anthony (1973) analyzed the results of seven reported studies on learning by discovery. He found that successful discovery training, where the individual is given practice in discovering rules, is more effective in subsequent learning than is didactic training where the individual is given rules.

Reid and Gallagher (1975) and Bender (1976) demonstrated that actively involving the child in problem solving facilitated acquisition of a conceptual generalization. These authors suggested that encouraging the child to actively manipulate materials to discover generalizations for themselves was a more effective method of teaching than merely giving instructions, with necessary repetitions, and answering any questions. In other words, the child must be allowed to act rather than to just model. Going one step farther, and relating to the previously stated need for understanding of the organization of material in order that efficient recall occur, Rozanova (1959, as reported by Smirnon and Zinchinko, 1969) found that activity aimed at specific goals resulted in better recall of material than did activity aimed at conditions for achieving a goal.

The effects of instructions on behavior and performance was discussed by Bijou and Baer (1967). They emphasized that differences in instruction can result in significantly different behaviors. This was extended into the classroom situation by Allington (1975) and Lovitt and Smith (1972). Allington suggested that often the child is given instructions without first ensuring his attention to the appropriate features of the task. Further, he suggested that the child is often not given the opportunity to summarize the application of a task to other situations, i.e., the opportunity for application of previously taught skills to the present task. Lovitt and Smith (1972) stated that consistent, clear description of the behavior required should be the first approach in attempting to change a child's behavior. These authors contended that one possible explanation for performance below that of teacher expectations is that children are not sure what is expected because they have never explicitly been told what to do. Another factor is inconsistent and/or a barrage of instructions which may only confuse some children. They concluded that academic behaviors such as reading, writing or speaking can be positively influenced by careful, consistent instructions.

Work by Miller (1956) and Underwood (1951) has emphasized the importance of organization in memory. Similarly, Cohen (1973) found that recall is affected by the organizing strategy used by the individual. Learning disabled children have been depicted as unable to organize and retain stimuli in memory (e.g., Birch, 1964; Johnson and Myklebust, 1967; Strauss and Lehtinen, 1947). Freston and Drew (1974) and Parker, Freston, and Drew (1975), in studying recall performance, found that learning disabled children did not take advantage of externally organized material. Similarly, Estes (1974), in looking at the digit span subtest, suggested that an individual may not perform at the expected level of his age group if he has not developed chunking to the level common to his age. Levin (1970) and Levin and Rohwer (1968) found that serial recall in children was facilitated by verbal organization (sentences) which sequentially related items in a list. The AFHRL paper (1974) elaborated some examples of mnemonic techniques:

"(a) Visualization - For example, in trying to associate a face to a name we may visualize a Mr. Carpenter as hammering that long spiked nose of his into a wall.

(b) First letter - For example, in order to remember the ordering of the 12 cranial nerves many of us have learned the phrase "On old Olympus' towering top, a fat-assed German vaults and hops." The first letter of each word is also the first letter of one of the major cranial nerves.

(c) Peg word - For example, a person has previously learned a serial list such as "one is a bun, two is a shoe, three is a tree...," as a new word comes in it is visually associated with the corresponding peg word.

(d) Narative chaining - Integration of each word to be learned sequentially into a story.

(e) Method of Loci - For example, mentally placing items in various distinct locations in your home [p. 41]." Their review of the research suggested that these techniques are more effective in learning serial recall and paired associate lists than is rote rehearsal.

Cole _et_ _al_. (1971) and Scribner and Cole (1972) found that in order to effectively use categories, children must first identify the appropriate category clues during learning, and then use these cues effectively for retrieval during recall. While the child may be aware that items can be categorized, he may be unaware that he can, and should use this strategy in appropriate learning tasks. This was further substantiated by Brown and Barclay (1976), who suggested that training of specific memory skills alone may not be effective in facilitating a significant improvement in cognitive functioning. The child may require training in both mnemonic strategies and their appropriate use. Similarly, Reigel _et al_. (1973) emphasized that understanding of the organization of material is a prerequisite to understanding the actual material. In this respect, the learning disabled child may be far behind his peers in that not only does he not organize material, he may not realize the necessity to do so (Torgeson, 1977).

Speech is an extremely important connecting agent between stimuli perceived and learning. Luria (1969) stated that "the process of mastering human experience is by speech and leads to the formation of new methods of activity...[p. 128]." He stated that speech regulates activity, first externally, then in whispered form, and finally internally.

Jensen (1966) also emphasized the importance of verbal mediation in learning. He stated that the nonmediator makes motor responses directly to sensory inputs while the mediator responds to verbal or other symbolic associations resulting from sensory stimuli. Similarly, Luria

(1969) noted that verbal labelling with meaningful words can produce significant changes in perception and discrimination. Thus, verbal mediation allows for generalization and transfer of experience rather than having responses being specific to a stimulus. Jensen (1966) stated that verbal mediation is a function of the availability of mediational elements, e.g., labels, vocabulary, associative ability, and of the arousal level of the individual to mediational activity. The arousal level is a function of practice and reinforcement of previous verbal labelling and mediating experience. Tasks which do not immediately appear to be verbal do not tend to arouse verbal mediation in children who have not developed these tendencies. The Raven's Coloured Progressive Matrices test (Raven, 1960) does not arouse verbal behavior in those children with a high threshold. Thus, they ineffectively attempt to solve the problem on a perceptual level. Bridgeman and Buttram (1975) suggested that the poor nonverbal reasoning performance of black children may be a result of their inefficient use of verbalization of problem solving strategies. Jensen (1968) had stated that a lack of spontaneous verbalization is more detrimental to performance on a nonverbal task than to performance on a predominantly verbal test. Bridgeman and Buttram (1975) found that significant race differences in performance disappeared when children of both races were taught to verbalize their problem solving attack. They suggested that conceptual strategies can be taught, and that poor academic performance may be partially due to the failure of schools to explicitly teach these strategies to children who have not already acquired them before entering school. While this study was criticized by Humphreys (1976) for poor statistical treatment, it does suggest a trend toward improved performance after taught verbal mediation. Studies by Zack and Kaufman (1969) and Chovan and McGettigan (1969) indicated that vocal mediation also reinforced visual-motor performance.

Dornbush and Basow (1970) stated that visual perception is more dominant than auditory perception for young children. Since young children attend to only one stimulus modality at a time, they may not attend well to auditory instructions for visual material. Corsini (1972) found that kindergarten children perform best when both verbal instruction and concrete material are used. When verbal instructions were not present, the child failed to actively code or mediate instructions. He suggested that pairing verbal instructions and nonverbal cues may be an important factor in the development of spontaneous internal verbal mediation. It has been suggested that the degree of learning in learning disabled children was greater when visual as opposed to auditory presentation was used (Byran, 1972; Estes and Huizinga, 1974; Otto, 1961). Byran (1970) noted that learning disability may be related to poor development of mediational strategies, particularly verbal rehearsal. Sperling (1963) also emphasized the importance of auditory coding and (preferably verbal) rehearsal in visual tasks. Conversely, Sapir and Wilson (1974) found that symbolic verbal mediation facilitated transfer from the auditory to the visual modality.

In reviewing the recent literature in the area of modification of impulsive responding, Bender (1976) concluded that, even more than strategy training, self-verbalization of the strategies was an effective remedial technque. In a study using first grade children, Bender employed five different treatment groups: Verbal self-instruction plus strategy training; strategy training only; verbal self-instruction only; attention to materials; and no treatment. She found that training which included both verbal self- instruction and strategies was most effective in reducing impulsive responses. She also found that self-verbalization of strategies was slightly more effective than general self-verbal instruction.

The preceding review of the literature in this section would appear to have important implications for further research in the area of learning disabilities. The learning disabled child may not have developed age appropriate organizational and mediational strategies and the awareness that he can effectively use these strategies in learning.

This may be due in part to passive interaction with perceived information, poor provision for appropriate attention to new tasks, unclear or multitudinous instructions, and poorly developed verbal mediation skills. Parker *et al*. (1975) and Estes (1974) suggested that it may be possible through direct instruction to teach learning disabled children to use the organization around him in order to facilitate performance. It has been suggested that such training can be done through organizational strategies, classification and grouping strategies, and instructions in mnemonic devices, as well as by teaching the child to be actively involved in the use of effective strategies (e.g., Parker *et al*., 1975; Reigel *et al*., 1973; Ring, 1976; Torgeson, 1977; Wirtenberg and Faw, 1975). The applicability of such training was shown by Stevenson, Parker, Wilkingson, Hegion, and Fish (1976). They conducted a four year study examining the effectiveness of various cognitive and psychometric tasks in predicting arithmetic and reading achievement, and concluded that repeated practice in strategies focusing on learning and remembering, e.g., remembering series of digits and words and organizing according to strategies, may be an effective method of improving cognitive skills.

Information Processing

Chalfant and King (1976), in summarizing the more widely used definitions of learning disability, noted that specific processing dysfunctions are often an integral part of these definitions. Information processing models have been put forth as a method for understanding the psychological processes mediating between the sensory input and an individual's response. One such model was proposed by Chalfant and King (1976). This model identifies five processes, i.e., attention, discrimination, memory, integration, and concept formation and problem solving, which mediate between stimulus input which can be auditory, visual, or haptic in nature, and response output, which can be either movement or vocal. Inferences about the psychological processes are made from behavioral responses. While these authors attempted to operationalize the processes with questions relating to the child's input and output systems, input, processes, and output are not clearly integrated. In other words, while process weaknesses can be inferred from test responses, there is no direct relationship outlined between the method and type of stimulus input, the concurrent style of processing, and subsequent form and type of response.

An information processing model which does integrate input systems, processes, and output systems has been proposed by Das et al. (1975). These authors based their model on the theory of successive and simultaneous syntheses put forth by Luria (1966a, 1966b).

On the basis of previous clinical work on persons with brain lesions (Luria, 1966a, 1966b, 1970), Luria (1973) has elaborated on the synergistic and hierarchical relationship among three units of the brain in order to view the nature of mental activity. The first functional unit is located mainly in the brain stem, the diencephalon, and the medial regions of the cortex. The function of this unit is to regulate and to modify cortical tone via the principle of gradual changes and, thus, to provide control over inclinations and emotions. The second functional unit is located in the posterior divisions of the cerebral hemispheres, i.e., the occipital (visual), temporal (auditory), and parietal (general sensory) regions of the cortex. This unit, which works in accordance with the 'all or nothing' rule, is involved with the reception, coding, and storage, i.e., analysis and synthesis, of incoming information. The third functional unit is located in the anterior regions of the cerebral hemispheres, i.e., the prefrontal regions of the cortex (which reach complete maturation between the ages of four and seven years). This unit is involved with the formation of intentions and plans and the regulation and verification of conscious activity.

Luria correlated disturbances in information processing with lesions in the second functional unit. He also elaborated on the hierarchical organization of cortical zones which characterizes this unit. The primary or projection areas of the cortex receive the (information) impulses, which have been analyzed into elementary components, from (or send impulses to) the periphery. The secondary or projection-association areas of the cortex are involved with coding of elementary components (of incoming information) or the organizing of programs. The tertiary or cortical zones of overlapping are responsible for the storage of (information) impulses by enabling groups of (modal-specific) analyzers to work efficiently together in synthesizing information.

Luria suggested that an individual has two essential integrative modes which are available for the processing of sensory information, namely, successive and simultaneous syntheses. More specifically, successive synthesis was viewed as being crucial to the processing of sensory stimuli into a serially organized group which does not encompass a 'surveyable' system of relationships, while simultaneous synthesis was viewed as being crucial to the processing of sensory stimuli into a 'surveyable' system of relationships. Based on studies of adults with specific and specified brain lesions, Luria has presented evidence which linked successive synthesis with the frontal and fronto-temporal regions of the brain and simultaneous synthesis with the occipito-temporal regions of the brain. Lesions in the frontal and fronto-temporal regions were reported to result in a general inability "...to integrate individual motor and acoustic stimuli into successive, serially organized groups" (Luria, 1966a, p. 125). However, lesions in the parieto-occipital regions were reported to result in a general inability "...to integrate individual visual or tactile stimuli into simultaneous and, in particular, spatially organized groups" (Luria, 1966a, p. 125). Dealing with just presentation, as opposed to integration of material, Dornbush and Basow (1970) suggested that sequential or successive presentation facilitates auditory recall, while simultaneous presentation facilitates visual recall. McFarlane-Smith (1964), Lashley (1960, and Pribram (1958), although subscribing, to varying degrees, to the concepts of parallel (simultaneous) and serial (successive) processes, do not fully agree on the localization of these cortical processes.

Simultaneous processing refers to the integration of ununited stimuli into contemporaneous, primarily spatial groups. In this type of processing, any part of the result can be examined, regardless of its position in the whole. Luria hypothesized that simultaneous synthesis is of three varieties, since it may occur during direct perception (input), in memory, and in complex intellectual processes.

In direct perception, essential elements of a stimulus are gradually distinguished, then are synthesized into a single unity. Luria contends that this kind of formation is, even in the case of the acoustic analyzer, primarily spatial. Mnemestic processes refer to the recall and organization of stimulus traces. For example, the individual may reconstruct the gestalt of a visual image when only portions of the image are given consecutively. In complex intellectual processes, simultaneous representation of the components of a system allows for survey and determination of the relationships between components.

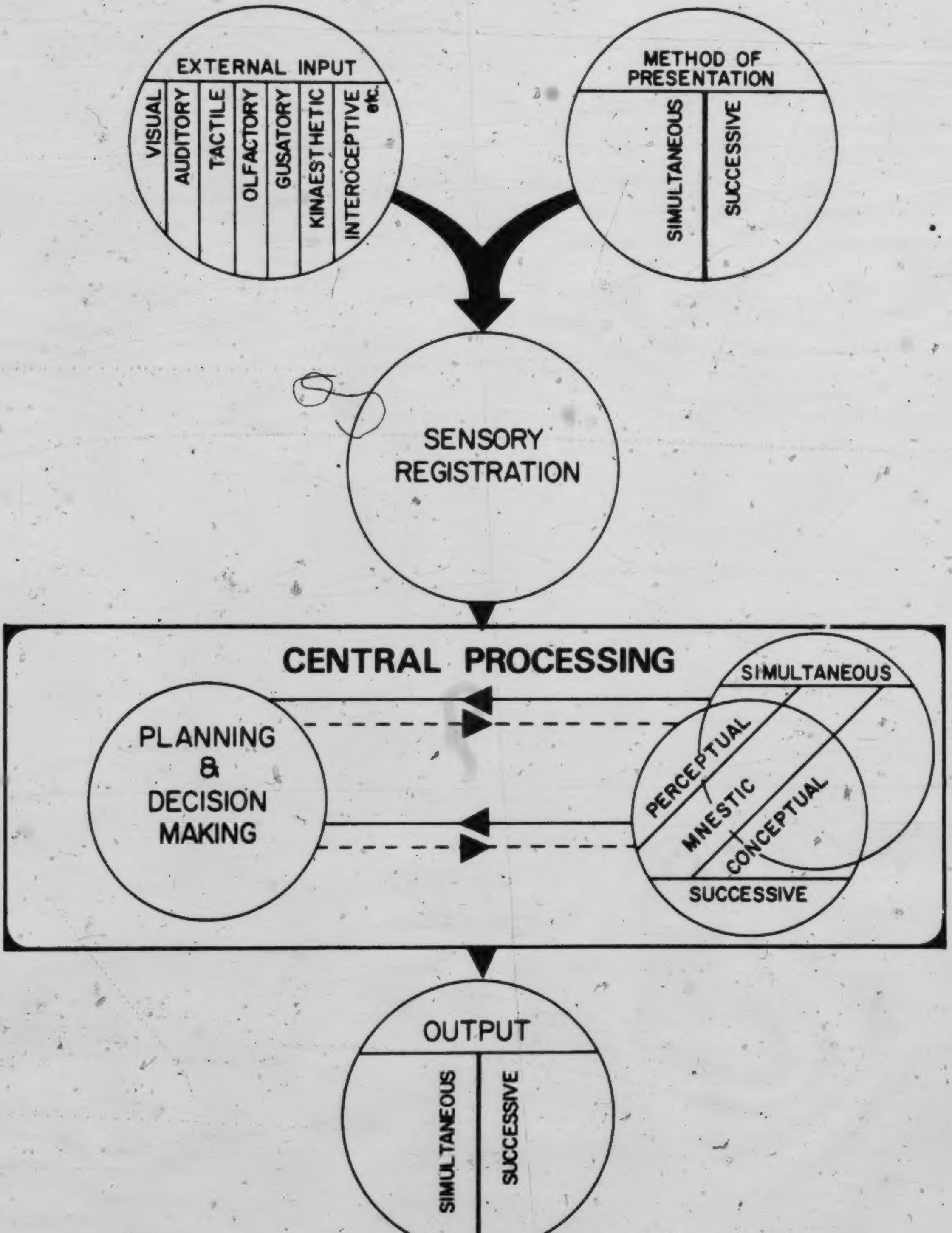
Successive processing refers to the processing of information in serial order. As opposed to simultaneous processing, the group is not completely surveyable at any one point in time. Successive processing is also hypothesized as being of three varieties, namely, sensorimotor (input), mnemestic, and complex intellectual. An example of sensorimotor perception is sequential components of a skilled movement, e.g., writing. Luria refers to the mnestic variety as "rhythmic" or "kinetic melodies" where each stimuli supports the next link in a successive action. Luria cites human speech as the most obvious example of intellectual successive processing.

Based on the formulations of Luria (1966a, 1966b), Das *et al*. (1975) have viewed information integration in terms of four basic units. The first unit, or Input Unit, is comprised of two alternative methods by which a stimulus can be presented to the extero-, intero- or proprioceptors, namely, parallel (simultaneous) presentation or serial (successive) presentation. Immediately after presentation, the stimulus is registered (simultaneously) by the second unit, or Sensory Register or Buffer, and is transmitted (serially) to the third unit, or Central Processing Unit. In accordance with the requirements of the task, the fourth unit, or Output Unit, determines the appropriate (successive or simultaneous) organization of output. This model is illustrated in Figure 1.

The relationship between the Buffer and the Central Processing Unit has been conceptualized by Das _et al_. (1975) as reciprocal, i.e., the Buffer interrupts the Central Processing Unit in order to subsequently force the Central Processing Unit to accept sensory information. However, the Central Processing Unit has been conceptualized as being responsible for the interrogation of the Buffer as a means to determine if anything is in the Buffer and if so, to allow a transmission to be made. The Central Processing Unit is comprised of three major components. Based on Luria's (1966b) findings, each of these components has been identified with the functions of specific areas of the cortex. The processing of separate information into simultaneous groups has been attributed to the occipital-parietal area, while the processing of discrete information into

Figure 1

Model of Information Processing


EXTERNAL INPUT
VISUAL
AUDITORY
TACTILE
OLFACTORY
GUSATORY
KINAESTHETIC
INTEROCEPTIVE etc.
METHOD OF PRESENTATION
SIMULTANEOUS
SUCCESSIVE
SENSORY REGISTRATION
CENTRAL PROCESSING
PLANNING & DECISION MAKING
SIMULTANEOUS
PERCEPTUAL
MNESTIC
CONCEPTUAL
SUCCESSIVE
OUTPUT
SIMULTANEOUS
SUCCESSIVE

temporally organized successive series has been linked to the anterior regions, particularly in the fronto-temporal area. The third component, which enables the formulation of coded information into the best possible plan for action, has been linked to the frontal lobe. Thus, the former two components are concerned specifically with the coding and storage of information, while the planning, regulating or controlling of conscious behavior has been attributed to the latter component.

Das et al. (1975) based their formulations on those of Luria (1966a, 1966b). However, Luria would appear to view information processing as a function of brain areas and their interrelationships, while Das et al. would seem to have extended Luria's conceptualizations to include both input received and output emitted by the individual. Both conceptualizations are rather boldly theoretical in that Luria, basing his generalizations on the effect of localized brain lesions on behavior, formulated the hypothetical constructs "simultaneous" and "successive" syntheses and has ascribed them to basically different areas of the brain. However, while the generalizations are based on those of Luria, the model has attempted to examine these processes without emphasis on brain localizations. In simplified terms, a common denominator between the two conceptualizations would appear to be (i) the entry mechanisms or stimuli, (ii) the internal mechanisms or processes which enable the assimilation, analysis, storage and retrieval of information, and (iii) the emission of observable, measurable behaviors (cf., Chalfant and Scheffelin, 1969). The first and third components have been investigated most frequently since they are more amenable to experimental manipulation. However, the second component does not afford direct observations, and has thus relied on inferential or correlational analyses of experimental manipulations to the first and third components.

The initial component may be regarded as encompassing the entry mechanisms by which information enters the organism; essential to this component is the delineation of qualitative aspects of task-specific information. Information may be acquired by any of the various sensory modalities (e.g., visual, auditory, tactual, olfactory, taste, kinesthetic, and/or equilibratory), and can be regarded as being independent of or dependent on environmental cues which either facilitate or inhibit previously and/or presently acquired learning skills. Within the subsequent component, conceptualized as encompassing the processing mechanisms, incoming information, which has been converted (via the neurophysiological and biochemical mechanisms) from one form of physical energy into another form of electrical potential energy, to some extent relies on the assimilation, storage, and subsequent retrieval of previously converted sensory information. This component relies heavily upon previously used strategies of processing information as well as on the success experienced by the individual with any one strategy. While the model assumes that the individual has both successive and simultaneous processing available, selection of one or both of the modes is dependent upon cultural and genetic factors and upon the demands of the presented task. Finally, within the conceptualized final product component, the processed sensory information is emitted as overt behavior, e.g., verbalizations or gestures, alone or in combination with covert behavior, e.g., reasoning.

The two centrally-mediated modes of processing were proposed as alternatives to the ability-level model postulated by Jensen (1970). The two modes, successive and simultaneous, are not postulated as being hierarchical. However, for some tasks, one process may be more efficient than the other.

Through the use of factor analyses, investigations have extended and operationalized Luria's formulations in samples of school children. Successive and simultaneous modes of processing information have been shown to be stable individual-difference variables in relation to IQ groups (Das, 1972; Jarman, 1975), age groups (Das and Molloy, 1975; Molloy, 1973), reading ability (Leong, 1974), learning disability (Williams, 1976), socioeconomic status (Das, 1973a), cultural groups (Das, 1973b; Krywaniuk, 1974);

and achievement levels (Krywaniuk, 1974). The actual tests used will be more fully described in later chapters.

One fairly consistent finding has been that many children experiencing academic difficulty are deficient in sequential strategy skills. Meier (1971) and Leton (1974) stated that learning disabled children have difficulty in processing sequential information. Richie and Aten (1976) and Jesseau (1974) found that reading disabled children have poorer ability in auditory nonverbal and visual sequences, respectively, than do children with adequate reading ability. Similarly, Badian (1977) suggested that the poor performance of retarded readers on auditory-visual integration tasks is due to poor temporal (auditory) sequential memory rather than to poor intermodal integration ability or to temporal spatial transfer difficulty. Krywaniuk (1974) also found low achievers to have poor verbal successive skills. Noelker and Schumsky (1973), in comparing sequencing, memory for form, and memory for position in normal and retarded readers, found that memory for position was the best discriminator between normal and retarded readers. The sequencing task, which does require position memory, was the second best discriminator.

Senf (1969) noted the difficulty of learning disabled children in consistently following instructional demands and in consistently ordering stimuli. Similarly, Bloom and

Broder (1950) found that low aptitude college students do not engage in sequential construction of understanding. They also frequently fail to read or to try to comprehend instructions. Bloom and Broder (1950) also found these students to be more passive responders, relying on a few clues, a guess or an impression rather than actively and sequentially attacking a problem. In the same light, Wirtenberg and Faw (1975) suggested that the learning disabled child attacks new problems in a trial-and-error manner, rather than actively and sequentially attacking the problem on the basis of previous successes. Concomitantly, Byran (1972) suggested that the use of a mediational strategy appears to be necessary in mastering auditory and visual sequencing, and that learning disability may thus be related to poor development of mediational strategies.

Luria hypothesized the mnemestic variety of successive processing as "kinetic melodies" where each stimulus supports the next link in a successive action. Eakin and Douglas (1971) stated that automatized behaviors are those which are highly practiced, and thus require a minimum of conscious effort for efficient execution, e.g., walking, reading, talking. A disabled reader has not automatized the process skills of reading. They contend that poorly developed automatic habits are most noticable when the child is faced with sequential material, such as serial memory and massed serial performance (e.g., WISC-R Picture Arrangement subtest). It would appear that oral reading disabled children have not developed simple automatic habits although comprehension may be unimpaired. They suggested that arithmetic achievement also relies heavily on automatized computational habits.

Goldman (1972), studying the learning strategies of undergraduate students, emphasized the utility of including strategies in studies of learning and recall. A review of the recent literature has revealed a growing awareness on the part of educators of the importance of focussing on deficiencies in strategies of information processing as opposed to observed weaknesses in auditory and/or visual perceptual and/or expressive areas. D'Annunzio and Steg (1974) have stressed the importance of knowledge of a child's learning strategies; in other words, noting a child's response to a presented stimulus will allow clinical inferences to be drawn regarding the child's operational strengths and weaknesses. Similarly, Whimbey (1976) stated that in order to teach a child to learn, the educator must uncover the child's thought processes in order to teach each step involved in problem solving. Sabatino and Hayden (1970) conceptualized that information processing behaviors may offer a systematic method of relating prescriptive teaching inputs to specific strengths and weaknesses. Similarly, Estes (1974) has pointed out the need for understanding the correlates leading to specific intellectual competence or incompetence. Findings of Klausmeier and Meinke's (1968) study, which used university students, have supported the feasibility and effectiveness of teaching task-specific strategies. In other words, providing subjects with instructions which taught a strategy of learning facilitated performance efficiency.

The instructional amenability of one of the strategies in the Das et al. (1975) information processing model, namely, the successive processing strategy, has been demonstrated. Investigating the relationship between school success and successive and simultaneous processing strategies, Krywaniuk (1974) concluded that high achieving children were so functioning as a result of having mastered both successive and simultaneous strategies, and being able to match the appropriate strategy with the demands of a specific task (cf., Cole et al., 1971; Scribner and Cole, 1972). In contrast, children who were low achievers, for example, in reading skills, were characterized as having poor verbal-successive processing skills. Subsequently, Krywaniuk designed a non-academically oriented intervention program which emphasized a verbal-successive strategy. Results indicated that the intervention program was successful in that improvement was generally noted in performance, and factor loadings were successfully altered. An unexpected finding, however, was the improvement in word recognition (on the Schonell Graded Word List) which Krywaniuk also attributed to the intervention program. In other words, training in verbal-successive skills resulted in greater facility at word attack skills and thus a gain score in word recognition. The results of this program support the interpretation that successive processing is a trainable strategy.

Another study which supports the successive-simultaneous information processing model was conducted by Bergan, Zimmerman, and Ferg (1971). This study, which preceded those of Das, was an investigation of the effects of content and groupings on sequential recall. The results of their factor analysis yielded three factors, memory for multiple units, memory for single units, and achievement and intelligence. The first two factors are clearly similar to simultaneous and successive processing, respectively.

An information processing orientation is indirectly supported by research which demonstrates that children perceive and process stimuli in two essential ways, namely, as parts of the whole stimulus and as a whole stimulus (e.g., DeHirsch, 1973; Goins, 1958). Quite apparent is the conspicuous similarity to successive and simultaneous processing, respectively.

The child with learning difficulties may have problems in either the registration or the integration of information (Das, 1973c). Whereas the registration of information may be a function of attention, integration may be a function of successive and simultaneous processing as well as the speed of synthesis of information. It was suggested that remediation must be concerned with determining the cause of the difficulty and formulation of an appropriate program. In this framework, the identification of problem learning areas is not viewed solely as the procedure of isolating specific deficiencies, such as problems of sound blending in reading exercises. Rather, it requires the identification of the deficient or inappropriate strategies of processing specific information. Thus, while previously mentioned remedial approaches, i.e., psycholinguistic training and perceptual-motor training, focus on discrete processes, a remedial approach within the successive-simultaneous processing model would focus on strategies encompassing these discrete processes. In other words, the child would be trained in organizational and mediational strategies, which he could be taught to transfer to discrete skills. This would seem to be a viable alternative, one which would place the focus of remediation on a sometimes forgotten aspect of learning. As Meeker (1964) stated, it "would seem that teaching the ability to learn should be considered as equally important to a goal as is a mastery of the presribed content [p. 4]." To date, there has been little remedial focus on the type of internal processing employed by the individual.

A theoretical basis for such a remedial approach however, exists in the information processing model outlined above. Before Krywaniuk's (1974) thesis, Molloy (1973) had considered the need to determine whether, in fact, the inferred processes of simultaneous and successive syntheses play differential roles in determining the effectiveness of a child's performance on cognitive tasks. He had also stressed the need to determine if individual preference for an inappropriate mode of processing can be modified.

Implications from previous, although indirectly related, research which has been discussed in the preceding chapter would seem to suggest that a child's performance on cognitive tasks is, indeed, affected by strength or weakness in the inferred simultaneous and successive integration processes. For example, learning disabled children have been shown to be weak in sequential skills (e.g., Meier, 1971). More directly related evidence has been provided by Krywaniuk (1974) who found low achieving children to be deficient in verbal-successive processing skills. Cummins and Das (1977) have shown that while children with high levels of reading achievement were high in both successive and simultaneous modes of processing, children who are experiencing difficulty in reading are dependent upon the (inefficient or poorly developed) successive mode of processing. If, as was suggested by Torgeson (1977), a learning disabled child is an inactive learner who is not aware that he can, and should develop efficient learning strategies, then modification or development of individual process preferences should be a viable remedial technique. Many authors contend that teaching the individual how to learn is an important, although often neglected, part of formal education (e.g., Brown and Barclay, 1976; Meeker, 1964; Reigel et al., 1973). Krywaniuk (1974) demonstrated that cognitive performance and word reading ability were facilitated by a non-academically oriented intervention program.

While the research by Krywaniuk (1974) has suggested that remedial intervention can increase test scores and change factor loadings, the focus now must be in researching the applicability of this model to the classroom situation. In other words, will remedial intervention stressing one or another mode of information processing alleviate academic learning difficulties and facilitate academic achievement. Independent findings from other researchers have suggested that training in strategies stressing one or both modes of information processing does indeed transfer to academic learning situations. Hays and Pereira (1972) conducted a two year study, following kindergarten children on into Grade 1, which investigated the effects of memory training on reading ability. The first year involved intensive small group training in visual memory, while both visual and auditory memory were trained in the second year. Focus was on meaningful association and classification, visualization, and verbal rehearsal. They found that the techniques used resulted in a significant improvement in reading achievement, as measured by the Gilmore Oral Reading Test, for the experimental group. The teachers involved felt that improved attention developed by the training program resulted in better ability to absorb instruction. Talcott (1971) reported "fairly good luck" with a program which incorporated visual, auditory, and tactile sequencing activities related to visual and printed stories in reading. Similarly, Hallenback (1976) found comic strips useful in developing sequencing, abstract thinking and classification abilities.

Summary:

In the interest of clarity, the essence of this chapter can be summarized in point form:

1. The area encompassed by the term learning disabilities is wide, with unclearly defined limits and fraught with diverse definitions, diagnostic and remedial techniques.
2. Recent emphasis in the area has been on the observable behaviors of learning disabled children.
3. Although information processing models have been proposed, the underlying psychological processes have to be inferred from observable behavior.
4. Currently popular remedial approaches tend to focus on discrete psychological processes and have been

relatively ineffective in facilitating either cognitive growth or academic performance.

5. The ways in which an individual learns, i.e., strategies of learning, have been shown to be important modifiable factors in individual performance.
6. The learning disabled child is often assumed to lack ability in a psychological process. However, poor performance may be a result of the child using inefficient strategies, rather than a lack of the ability itself.
7. Strategies which have been shown to be weak in learning disabled children include poor organization of material, inactive participation in learning, poor awareness of when strategies should be used, and poor use of verbal mediation.
8. A model of information processing has been suggested which includes two integrative processes. These processes, successive and simultaneous, can be considered as methods by which the brain codes information. They can be involved in different tasks to different degrees or at different levels of complexity.
9. Successive and simultaneous modes of information processing have been shown to be stable variables in examining individual differences within and across varying samples.
10. Intervention programs, one of which was derived from the successive-simultaneous model, have been conducted.

In general, they show that strategy training can improve academic performance.

Thus, the groundwork has been laid for an intervention study which investigates the extent to which strategy training may lead to not only better performance in successive or simultaneous processing, but to improved performance in some academic tasks such as reading and arithmetic.

CHAPTER III

EXPERIMENTAL PROCEDURES: A DESCRIPTION OF THE SAMPLE AND TESTING PROCEDURE

Selection of Subjects

Sixty-eight Grade 4 children from the three schools of the Canadian Armed Services, Edmonton, were used in the present study. The Canadian Armed Services schools were used since the author and his wife had worked extensively in these schools in previous years and were on good terms with teachers and administrators. Total time, including group testing, for each child involved in the study was between 20 and 25 hours per child. Since more than half of this time was spent with each child on an individual basis, teachers had considerable reorganization of teaching schedule and repetition of material missed by experimental subjects. Thus, teacher and administrative cooperation and goodwill were vital.

One reason for choosing Grade 4 students was that these teachers were most cooperative and, in the five classrooms, had the greatest enrollment of the upper primary grades. The ages of the children ranged from 101.2 months to 137.6 months with a mean age of 113.9 months (SD=6.91).

Selection of subjects was based on the scores from the Metropolitan Achievement Test (MAT): Elementary Battery-

Form G. An achievement test was used since it was a logical basis from which to determine academic level. Although the Canadian Test of Basic Skills was administered twice during the school year by each classroom teacher, these were not given at the same time in all schools and thus all scores were not available for use in determining remedial groups. The MAT was selected since it is not one used in these schools, thus avoiding any practice effect from previous administration. Each MAT battery (e.g., Primary I, Primary II, and Elementary) has at least three forms. The battery used was specifically designed for Grades 3 and 4 and has percentile and stanine norms for the beginning and end of each year. Thus, it was possible for different forms of the MAT to be given at pre- and post- testing sessions.

A second reason for choosing Grade 4 students, was that the reliability data for the MAT, as given in the manual, were for tests administered at the beginning of Grade 4. Although the MAT was standardized in the United States, post hoc analysis of data from the present study indicated that the Canadian Test of Basic Skills and the MAT yielded similar scoring patterns for the student.

The MAT is composed of seven subtests, and two separate derived composite scores for reading and mathematics. Subtests include "Word Knowledge," "Reading," "Language," "Spelling," "Mathematics Computation," "Mathematics Concepts," and "Mathematics Problem Solving." The composite score for reading is a summation of the child's scores on "Word Knowledge" and "Reading." The composite score for mathematics is a summation of "Mathematics Computation," "Mathematics Concepts," and "Mathematic Problem Solving." Raw scores on subtests can be converted to grade equivalents, percentile ranks, and stanines. Table 1 shows the stated reliability coefficients for each of the MAT subtests, Form G, administered at the beginning of Grade 4. The composite scores for reading and mathematics had the highest reliability coefficients.

The MAT was administered in its entirety on a group basis in each school to all 104 children in Grade 4. Subtests were administered in the sequence in which the test booklet was designed. Each subtest was administered on the same day to all five classrooms. Administration of the test was done over one week in October, 1976, with "Word Knowledge" being given on the morning of the first day, "Reading" the morning of the second day, "Language" in the morning of the third day, with a five minute break between parts A and B, "Spelling" in the afternoon of the third day, "Mathematics Computation" in the morning of the fourth day, "Mathematics Concepts" in the afternoon of the fourth day, and "Mathematics Problem Solving" on the morning of the fifth day.

Following testing, each test booklet was scored, the derived scores found, and the mean of the reading composite

Table 1

Reliability Coefficients and Standard Errors of Measurements of Metropolitan Achievement Test Subtests

SUBTESTS	R(K-R)	R(S-H)	Std. Error of Meas. RS	SS	GE
WORD KNOWLEDGE	.94	.95	2.5	2.7	.3
READING	.92	.93	2.5	3.9	.4
READING COMPOSITE	.96	.97	3.5	2.5	.3
LANGUAGE	.93	.93	2.8	3.5	.4
SPELLING	.96	.97	2.0	2.2	.3
MATH. COMPUT.	.88	.91	2.2	3.2	.3
MATH. CONCEPTS	.90	.91	2.4	3.7	.4
MATH. PROB. SOLV.	.91	.93	2.0	3.5	.4
MATH. COMPOSITE	.96	.97	4.0	2.2	.2

R: Reliability Coefficient

K-R: Saupe's Estimate of Kuder-Richardson Formula 20 Reliability

S-H: Split-Half (Odd-Even) Coefficients

and mathematics composite scores was calculated for each child. These composite mean scores were rank ordered and trichotomized. On this basis, three groups of children were formed across the five classrooms, i.e., "Below Average," "Average," and "Above Average." Those children who had grade equivalent composite score means between 2.5 and 3.2 were designated as "Below Average;" those whose scores were between 3.7 and 5.5 were designated as "Average;" and those whose scores were above 5.6 were designated as "Above Average." Those children designated as "Above Average" (36 children) were not used in the present study.

The scores of the 68 remaining children were rank ordered for both the "Average" and "Below Average" groups, with 34 children in each group. These children were then alternately selected for either the Control group or the Experimental group, giving 17 children in each of the four groups, i.e., "Below Average" Experimental, "Below Average" Control, "Average" Experimental, and "Average" Control. Table 10 (which appears in Chapter V) shows the distribution of experimental and control subjects, and further subdivision according to sex, within the five Grade 4 classrooms of the three schools.

To test for the significance of differences between the "Average" and "Below Average" scores, analyses of variance (ANOVA) were computed on the Grade Equivalent Reading and Mathematics Composite Scores. Both ANOVAs revealed significant differences between the "Average" and "Below Average" scores (Reading: $F=43.91$, df 1/64, $P<.001$; Mathematics: $F=79.79$, df 1/64, $P<.001$). Since the ANOVA was based on collapsing the Experimental and Control groups, a t-test for independent means (Winer, 1962) was used to test the differences between "Average" and "Below Average" scores in both the Experimental and the Control groups. These t-tests revealed significant differences between "Average" and "Below Average" scores in the Experimental group (Reading: $t=5.44$, $df=32$, $P<.001$; Mathematics: $t=6.34$, $df=32$, $P<.001$), and "Average" and "Below Average" scores in the Control group (Reading: $t=4.49$, $df=32$, $P<.001$; Mathematics: $t=5.76$, $df=32$, $P<.001$). Separate t-tests for independent means (Winer, 1962) confirmed that there was no significant difference between the Control and the Experimental groups for the "Below Average" or the "Average" subgroups.

School Cumulative Files and Health Records were examined to ensure the exclusion of children with history of prolonged disease or seizures, and children with IQ's below 85. No children could be excluded on these bases. Files were also checked for any noted visual or auditory problems. Children who had had lenses prescribed were always seen wearing their lenses. IQ scores, as measured by the Otis Lennon, Elementary I Form J, ranged from 95 to 127 ($\overline{X}=109.38$; $SD=7.04$). T-tests for independent means (Winer, 1962) confirmed that there was no significant difference between the IQ scores for Experimental and Control groups or for the academically "Average" and "Below Average" groups (t=-1.17, df=66, P>.05; t=1.71, df=66, P>.05, respectively). These scores were from testing done by the school principals in September, 1976.

While the "Below Average" group in the present study was not designated as, or assumed to be "learning disabled," it did conform to four of the five components of learning disability suggested by Chalfant and King (1976). The components were task failure, exclusion factor, physiological factor, and discrepancy component. The children were at least one year behind grade placement in academic achievement, and since the reading and mathematics composite scores had been averaged to arrive at group placement, the children were often farther behind in one or the other (task failure); none of the children evidenced mental retardation, sensory or physical handicaps (exclusion factor); none of the children evidenced genetic variations or biochemical irregularities (physiological factor); and academic functioning level was below that expected from intellectual functioning level (discrepancy component). By the end of intervention, it was clinically apparent that many of the children had "deficits" in one or more of the psychological processes designated by Chalfant and King (1976).

Administration of Primary Test Battery[1]

The successive-simultaneous information processing model was discussed in Chapter II. Previous research concerning the successive-simultaneous processing model (e.g., Das, 1972; Das, 1973b; Kirby, 1976) has consistently used a set battery of tests. Of these tests, six were used in the present study since previous research has revealed them to load consistently on the successive, simultaneous or speed factor. The following six tests, hereafter referred to as the Primary Test Battery, were used: Raven's Coloured Progressive Matrices, Memory For Designs, Digit Span-Forward, Color Naming, Serial Recall, and Free Recall. Previous research has shown that Free Recall, Serial Recall, and Digit Span-Forward load consistently on the successive factor. The Raven's Coloured Progressive Matrices and Memory For Designs have loaded consistently on the simultaneous factor while Color Naming has loaded on the speed factor. The Bender Visual Motor Gestalt Test and the Schonell Graded Word List were also administered in order to provide a quick evaluation of a child's perceptual motor functioning and a quick estimate of a child's ability to recognize words, respectively. These eight tests, collectively, will be hereafter referred to as the Marker Tests.

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[1] All testing, both group and individual, and all remediation in the present study were conducted by the author and his wife, a certified psychologist who has done extensive testing and remedial program planning under the Learning Disabilities Fund. Pre-testing on the MAT was done by the author, while all other pre-tests were done, on an individual basis, by his wife.

All Marker Tests were administered on an individual basis to each child. Testing was done on a school-by-school basis during November and December, 1976, and children in each school were tested in a random order. Each child was seen on two separate, successive days, with the Raven's Progressive Matrices, Memory For Designs, the Bender Gestalt and the Schonell being given on the first session, and Digit Span-Forward, Color Naming, Free Recall, and Serial Recall being given on the second day. The order of presentation was identical for each child. Each session averaged 45 minutes per child. These tests were then all scored by the author, with the exception of the Schonell and the Bender Gestalt, which were scored by the author's wife.

(a) Raven's Coloured Progressive Matrices (RCPM)

Ease of administration and the requirement of few verbal instructions have resulted in the RCPM (Raven, 1960) being a widely used culturally-reduced test of intellectual reasoning for children of age five to 11 years. Consisting of 36 matrices or designs, each having a part which has been removed, the task is to choose the missing insert from six possible alternatives. The 36 matrices are grouped into three series, each series comprised of 12 matrices of increasing difficulty. The earlier series require accuracy of discrimination, while the latter series involve analogies, permutation and alternation of pattern, and other logical relations. Each child responded on the standard form. The total number of correct responses was recorded.

(b) Memory For Designs (MFD)

Developed by Graham and Kendall (1960), this test has become one of the most popular tests for the assessment of brain damage in both children and adults. However, in the present study, its purpose is to merely provide a memory task of designs. The test material consists of 15 simple straight line designs which the subject is shown one at a time for five seconds each. The subject's task is to reproduce from memory each of the 15 designs. Each child was given one sheet of 8½" x 11" white paper, placed lengthwise in the usual position for writing. The actual stimulus cards from the test (5" x 5") were held at right angles to the child's line of vision, 18 inches from his eyes. An objective scoring system has been developed which encompasses the designation and subsequent summing of numerical values to the qualitatively different errors.

(c) Serial Recall (SR)

Presented individually by means of a tape recorder, the subject's task is to recall verbally, immediately following each presentation, 24 groups of four words which are either acoustically similar (e.g., man, mat, and mad) or 'neutral' (e.g., day, hot, and cow). Each series of four words is scored for words in the correct serial position. The maximum score is 96.

(d) Free Recall (FR)

Presented individually by means of a tape recorder, the subject's task is to recall verbally, immediately following each presentation, 24 groups of four words which are either acoustically similar (e.g., man, mat, and mad) or 'neutral' (e.g., day, hot, and cow). Each series of four words is scored for the total number of words correctly recalled. The maximum score is 96. The list of words given in this test is identical to the list given in the Serial Recall task.

(e) Color Naming (CN)

This task is based on one of the three developed by Stroop (1935). In the present study, the task was presented on a white background card (28" x 30"), having eight rows of colored bars with five positions in a row. The colored bars were 3" long and 3/4" wide. Red, green, yellow, and blue bars were alternated, to a total of 10 presentations of each color, in replication of the Stroop task. The child was placed seven feet from the card and after being familiarized with the working of a stopwatch, was asked to name each color, successively by rows. The score is the time, in seconds, it takes the child to complete the task.

(f) Digit Span-Forward (DS-F)

This task is the WISC (Wechsler, 1949) Digit Span-Forward. The child is read, by the experimenter, series of digits of increasing length, beginning with three digits, to a maximum of nine digits. If the child is unable to recall correctly any series of digits, he is given a second series of identical length. When the child fails to correctly recall both series of any one length, the test is discontinued. The score is equivalent to the highest series of digits correctly recalled, with a maximum of nine points.

(g) Bender Visual Motor Gestalt Test (BG)

Although developed by Bender in 1938, the test was formally introduced by Bender (1946) as a method to study visual-motor coordination. It has since become one of the most popular tests used in the evaluation of perceptual-motor functioning, neurological impairment, expressive styles, and maladjustment. The test measures the child's ability to perceive, analyze, and reproduce (with pencil and paper) a total of nine geometrical figures composed of circles, lines, or dots, with each figure of two or more integrated parts presented individually on a separate card. Each child was given one sheet of 8½" x 11" white paper, placed lengthwise in the usual position for writing. The actual stimulus cards from the test (6" x 4") were placed directly above this sheet. Errors of distortion of shape, rotation, integration, and perseveration were scored in accordance with Koppitz's (1971) method.

(h) Schonell Graded Word List (SCH)

Schonell (1942) developed this test to provide a quick, but accurate, estimate of a child's reading age, as well as an indication of the child's ability to recognize words. The test consists of 100 words divided into 10 words per year from ages five to 13 and 10 words for ages 14 and 15. Instructed to start at the top of the page and read across, the child's task is to read as many of the words as he can. The experimenter notes the child's pronunciation for each word and sums the correct responses.

Procedure For Post-Tests: Readministration of All Pre-Tests

Upon completion of the intervention phase (refer to Chapter V), all tests which had been administered by the experimenters prior to this phase, were readministered, in order to determine the effectiveness of intervention. The

MAT: Elementary Battery-Form F was readministered since while the tasks used in the intervention were not directly related to academic materials, the author wished to investigate the effect, if any, on academic performance (as measured by the MAT), of strengthening successive (and, secondarily, simultaneous) strategies by means of task related intervention. The MAT was readministered by the author to those classrooms in which he had conducted the intervention ('b^1' and 'b^2') and by the author's wife to those classrooms in which she had conducted the intervention ('a', 'c^1', and 'c^2'). Only those children involved in the study, in both the Experimental and the Control groups (68 children), were given the readministration. The 28 children in classrooms 'b^1' and 'b^2' were grouped together into one classroom, as were the 21 children in classrooms 'c^1' and 'c^2' (refer to Table 10, which appears in Chapter V). Those children not being tested in each classroom were occupied, by their teachers, in another room during testing.

Readministration of the MAT was done over the final full week of May, 1977, and was conducted in an order identical to that of the first administration. Subtests were administered in the sequence in which the test booklet was designed. Each subtest was administered on the same day in all three schools. "Word Knowledge" was given in the morning of the first day, "Reading" the morning of the second day, "Language" in the morning of the third day, with a five minute break between parts A and B, "Spelling" in the afternoon of the third day, "Mathematics Computations" in the morning of the fourth day, "Mathematics Concepts" in the afternoon of the fourth day, and "Mathematics Problem Solving" on the morning of the fifth day.

The Marker Tests were readministered during the two weeks following the readministration of the MAT. The author readministered these tests to the classrooms in which his wife had conducted the intervention ('a', 'c^1' and 'c^2'), while the author's wife readministered these tests to the classrooms in which the author had conducted the intervention ('b^1' and 'b^2'). Since these tests were administered on an individual basis, this method of readministration was used to avoid experimenter bias in favor of experimental subjects. For the purpose of readministration of these tests, children in both the Control and the Experimental groups were combined and listed randomly in the order in which they were to be tested. Both the author and his wife were known to children in both schools, thus the effect of having a "new" person as tester was minimized. All testing was conducted in the school nurse's office.

Readministration of these tests was conducted in an order identical to that of the first administration. Each child was seen on two separate, successive days, with the Raven's Coloured Progressive Matrices, Memory For Designs, Bender Gestalt, and Schonell being given on the first session, and Digit Span-Forward, Color Naming, Free Recall and Serial Recall being given on the second day. The order of presentation was identical for each child and was in the order presented above. Each session averaged 45 minutes per child. These tests were then all scored by the author, with the exception of the Schonell and the Bender Gestalt, which were scored by the author's wife.

CHAPTER IV

STATEMENT OF THE PROBLEM, HYPOTHESES, AND RATIONALE

Statement of the Problem

The general problem of this study is to demonstrate that remedial intervention stressing successive information processing (and secondarily, simultaneous processing) will not only facilitate performance on tasks which load on the successive factor, but that it will also have a facilitative effect on academic performance. The problem consists of several questions:

(a) Can cognitive performance in children ranging from academically "below average" to academically "average" be explained by the successive-simultaneous information processing model?

(b) Will remedial intervention which stresses the use of successive strategies improve cognitive performance?

(c) Will this remedial intervention change individualized efficiency in information processing?

(d) What is the relationship of academic achievement to the successive-simultaneous processing model?

(e) Will the effect of remedial intervention transfer to academic tasks in order to facilitate academic performance?

From the review of the literature presented in Chapter II, certain hypotheses can be drawn. These, along with their rationale, will be presented in this chapter.

Hypotheses and Rationale

HYPOTHESIS 1: Factor analysis of the Primary Test Battery will yield the factors of successive and simultaneous processing.

This is essentially an attempt to replicate the factor structures previously obtained (refer to Das *et al*., 1975). Previous research has shown that factor patterns for children experiencing academic difficulties are similar to those for children experiencing no academic difficulties. Williams (1976) found that the factors of successive and simultaneous processing and speed emerged from factor analysis of the data from his study involving identified learning disabled children. Leong (1974) also found similar factor patterns for severely disabled and above average readers, while Krywaniuk (1974) found similar factor patterns for high and low academic achievers. On the basis of these findings, it is expected that the same factors will be obtained in the present study in which scores from "below average" and "average" students will be combined for the purposes of factor analysis.

Previous research (e.g., Das, 1972; Das, 1973a) has consistently used a set battery of tests. Of these tests, six were used in the present study. The tests are: Raven's Coloured Progressive Matrices, Memory For Designs, Serial Recall, Free Recall, Digit Span-Forward, and Color Naming. These Tests have been discussed fully in Chapter III. Since these tests have been given to different samples in the past and have been included in a dozen or so factor analyses, it will be helpful to report their means, standard deviations and factor loadings. In Tables 2 to 7, the relevant data have been summarized.

The next two hypotheses concern the effects of intervention.

HYPOTHESIS 2(a): Improvement in performance on the successive and simultaneous marker tests following intervention will be greater for the Experimental group than for the Control group.

The successive and simultaneous marker tests are the six tests of the Primary Battery (i.e., Raven's Coloured Progressive Matrices, Memory For Designs, Serial Recall, Free Recall, Digit Span-Forward, and Color Naming), with the addition of the Schonell Graded Word List and the Bender Visual Motor Gestalt Test. The latter two tests were

Table 2

Comparison of Means, Standard Deviations, and Factor Loadings of the Raven's Coloured Progressive Matrices

Authors	Groups	Means	SD	Factor Loadings
Das, 1972	Non-Retarded (Gr. 2-3; N=60)	23.94	-	.792*
	Retarded (matched on MA; N=60)	19.10	-	.786*
Das, 1973b	Gr. 4 (Edmonton; N=60; High & Low SES)	-	-	.740*
	Gr. 4 (Orissa; N=90; High & Low SES)	-	-	.624*
Molloy, 1973	Low SES-Gr. 1 (n=30)	13.77	2.01	.784*#
	High SES-Gr. 1 (n=30)	15.37	3.21	.784*#
	Low SES-Gr. 4 (n=30)	25.57	4.24	.876*#
	High SES-Gr. 4 (n=30)	26.93	4.87	.876*#
Krywaniuk, 1974	Low Achievers-Gr. 3 (Hobema; n=38)	23.08	4.11	.668**
	Low Achievers-Gr. 3 (Edmonton; n=56)	23.84	6.43	.792*
	High Achievers-Gr. 3 (Edmonton; n=56)	29.98	3.97	.745*

* Simultaneous Factor Loading

** Successive Factor Loading

# combined SES

Table 2 (Cont.)

Comparison of Means, Standard Deviations, and Factor Loadings of the Raven's Coloured Progressive Matrices

Authors	Groups	Means	SD	Factor Loadings
Leong, 1974	Severely Disabled Readers ($\overline{CA}$=9-3 yrs.; n=58)	22.60	5.04	.802*
	Above Average Readers ($\overline{CA}$=9-3 yrs.; n=58)	28.19	3.70	.817*
Jarman, 1975	Low IQ (Males, Gr. 4; N=60)	23.23	4.89	.600*
	Normal IQ (Males, Gr. 4; N=60)	26.08	5.04	.552**
	High IQ (Males, Gr. 4; N=60)	30.95	3.38	-.590**
Kirby, 1976	Gr. 4 (Males, N=104)	28.55	4.39	.753*
	Gr. 4 (Females, N=98)	29.04	4.47	.793*
Williams, 1976	Learning Disabled (Gr. 2-6; N=51)	27.00	4.14	.775*

* Simultaneous Factor Loading

** Successive Factor Loading

Table 3

Comparison of Means, Standard Deviations, and Factor Loadings of the Memory For Designs Test

Authors	Groups	Means	SD	Factor Loadings
Das, 1972	Non-Retarded (Gr. 2-3; N=60)	5.54	-	.579[*]
	Retarded (matched on MA; N=60)	10.50	-	.830[*]
Das, 1973b	Gr. 4 (Edmonton; N=60; High & Low SES)	-	-	-.830[*]
	Gr. 4 (Orissa; N=90; High & Low SES)	-	-	-.809[*]
Molloy, 1973	Low SES-Gr. 1 (n=30)	16.50	6.09	-.713[*#]
	High SES-Gr. 1 (n=30)	12.67	5.82	-.713[*#]
	Low SES-Gr. 4 (n=30)	3.00	3.39	-.750[*#]
	High SES-Gr. 4 (n=30)	3.37	3.13	-.750[*#]
Krywaniuk, 1974	Low Achievers-Gr. 3 (Hobema; n=38)	3.82	2.84	-.831[*]
	Low Achievers-Gr. 3 (Edmonton; n=56)	5.52	4.29	-.764[*]
	High Achievers-Gr. 3 (Edmonton; n=56)	3.52	3.67	-.583[*]

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[*] Simultaneous Factor Loading

[#] combined SES

Table 3 (Cont.)

Comparison of Means, Standard Deviations, and Factor Loadings of the Memory For Designs Test

Authors	Groups	Means	SD	Factor Loadings
Leong, 1974	Severely Disabled Readers ($\overline{CA}$=9-3 yrs.; n=58)	8.57	6.48	-.808*
	Above Average Readers ($\overline{CA}$=9-3 yrs.; n=58)	4.43	3.02	-.585*
Jarman, 1975	Low IQ (Males, Gr. 4; N=60)	3.43	3.35	-.798*
	Normal IQ (Males, Gr. 4; N=60)	3.10	3.11	-.632*
	High IQ (Males, Gr. 4; N=60)	1.70	2.11	-.909*
Kirby, 1976	Gr. 4 (Males, N=104)	42.23	2.63	.810*
	Gr. 4 (Females, N=98)	42.03	3.41	.793*

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* Simultaneous Factor Loading

Table 4

Comparison of Means, Standard Deviations, and Factor Loadings of the Serial Recall Task

Authors	Groups	Means	SD	Factor Loadings
Das, 1972	Non-Retarded (Gr. 2-3; N=60)	30.55	-	.683*
	Retarded (matched on MA; N=60)	23.72	-	.855*
Molloy, 1973	Low SES-Gr. 1 (n=30)	58.57	25.51	.951*#
	High SES-Gr. 1 (n=30)	60.47	27.31	.951*#
	Low SES-Gr. 4 (n=30)	84.73	9.84	.950*#
	High SES-Gr. 4 (n=30)	86.30	10.87	.950*#
Krywaniuk, 1974	Low Achievers-Gr. 3 (Hobema; n=38)	92.39	32.78	.863*
	Low Achievers-Gr. 3 (Edmonton; n=56)	130.43	32.78	.917*
	High Achievers-Gr. 3 (Edmonton; n=56)	145.45	26.40	.913*
Leong, 1974	Severely Disabled Readers (CA=9-3 yrs.; n=58)	57.12	12.22	.888*
	Above Average Readers (CA=9-3 yrs.; n=58)	72.17	8.48	.817*

* Successive Factor Loading

# combined SES

Table 4 (Cont.)

Comparison of Means, Standard Deviations, and Factor Loadings of the Serial Recall Task

Authors	Groups	Means	SD	Factor Loadings
Jarman, 1975	Low IQ (Males, Gr. 4; N=60)	68.00	19.56	.656*
	Normal IQ (Males, Gr. 4; N=60)	78.30	17.16	.731**
	High IQ (Males, Gr. 4; N=60)	86.15	9.11	.582*
Kirby, 1976	Gr. 4 (Males, N=104)	54.42	12.98	.642*
	Gr. 4 (Females, N=98)	60.85	12.10	.560*
Williams, 1976	Learning Disabled (Gr. 2-6; N=51)	71.76	18.92	.922*

* Successive Factor Loading

** Successive-Speed Factor Loading

Table 5

Comparison of Means, Standard Deviations, and Factor Loadings of the Free Recall Task

Authors	Groups	Means	SD	Factor Loadings
Das, 1972	Non-Retarded (Gr. 2-3; N=60)	40.91	-	.757*
	Retarded (matched on MA; N=60)	32.17	-	.856*
Molloy, 1973	Low SES-Gr. 1 (n=30)	76.17	13.86	.955*#
	High SES-Gr. 1 (n=30)	76.93	4.10	.955*#
	Low SES-Gr. 4 (n=30)	90.40	6.38	.941*#
	High SES-Gr. 4 (n=30)	90.43	6.87	.941*#
Krywaniuk, 1974	Low Achievers-Gr. 3 (Hobema; n=38)	125.39	30.29	.852*
	Low Achievers-Gr. 3 (Edmonton; n=56)	147.61	28.24	.905*
	High Achievers-Gr. 3 (Edmonton; n=56)	159.68	18.23	.892*
Williams, 1976	Learning Disabled (Gr. 2-6; N=51)	83.17	9.87	.916*

* Successive Factor Loading

# combined SES

Table 6

Comparison of Means, Standard Deviations, and Factor Loadings of the Digit Span-Forward Task

Authors	Groups	Means	SD	Factor Loadings
Molloy, 1973	Low SES-Gr. 1 (n=30)	4.10	.71	.811*#
	High SES-Gr. 1 (n=30)	4.17	.75	.811*#
	Low SES-Gr. 4 (n=30)	5.23	.86	.801*#
	High SES-Gr. 4 (n=30)	5.57	.82	.801*#
Kirby, 1976	Gr. 4 (Males, N=104)	5.34	.94	.785*
Williams, 1976	Learning Disabled (Gr. 2-6; N=51)	5.15	1.07	.845*

* Successive Factor Loading

# combined SES

Table 7

Comparison of Means, Standard Deviations, and Factor Loadings of the Color Naming Task

Authors	Groups	Means	SD	Factor Loadings
Molloy, 1973	Low SES-Gr. 1 (n=30)	60.60	27.75	.801*#
	High SES-Gr. 1 (n=30)	59.27	21.17	.801*#
	Low SES-Gr. 4 (n=30)	36.40	7.03	.833*#
	High SES-Gr. 4 (n=30)	36.37	6.39	.833*#
Krywaniuk, 1974	Low Achievers-Gr. 3 (Hobema; n=38)	97.29	26.17	.739*
	Low Achievers-Gr. 3 (Edmonton; n=56)	79.54	19.13	.855*
	High Achievers-Gr. 3 (Edmonton; n=56)	72.73	19.72	.765*
Kirby, 1976	Gr. 4 (Males, N=104)	33.36	6.77	.904*
	Gr. 4 (Females, N=98)	30.92	4.86	.573*
Williams, 1976	Learning Disabled (Gr. 2-6; N=51)	36.68	8.71	.953*

* Speed Factor Loading

# combined SES

included for the purpose of examining the effect of intervention. The Schonell Graded Word List was used by Krywaniuk (1974). Table 8 presents a comparison of means, standard deviation scores, and factor loadings of the Schonell. The latter test, Bender Visual Motor Gestalt, can be compared to the Figure Copying Test (FCT). The FCT was adopted by Ilg and Ames (1964) as a means for determining developmental readiness for the traditional school learning tasks of the primary grades. The task requires the child to copy 10 geometrical forms which increase in difficulty and are visible to the child at all times. Table 9 presents a comparison of mean and standard deviation scores, and factor loadings of the FCT.

Previous research has demonstrated that training in the use of strategies has an advantageous effect on task performance. Using a sample of third grade low achievers, Krywaniuk (1974) was successful in his attempts to teach a verbal-successive strategy to those students who had been previously characterized as having poor verbal-successive skills. Following intervention, the maximum treatment group showed significant improvement on Color Naming, Serial Recall, Free Recall, Raven's Coloured Progressive Matrices, and Figure Copying. An important finding in his study was the significant improvement in word recognition, as was measured by the Schonell Graded Word List. Klausmeier and Meinke (1968) also found that teaching task-specific

Table 8

Comparison of Means, Standard Deviations, and Factor Loadings of the Schonell Graded Word List Task

Author	Groups	Means	SD	Factor Loadings
Krywaniuk, 1974	Low Achievers-Gr. 3 (Edmonton; n=56)	28.59	5.27	.701*
	Low Achievers-Gr. 3 (Edmonton; n=56)	28.59	5.27	.639**
	High Achievers-Gr. 3 (Edmonton; n=56)	44.80	10.18	.843**

* Verbal Intelligence Factor Loading (From a Battery of Achievement and Intelligence Tests)

** Reading Factor Loading (From a Battery of Achievement and Cognitive Tests)

Table 9

Comparison of Means, Standard Deviations, and Factor Loadings of the Figure Copying Test

Authors	Groups	Means	SD	Factor Loadings
Das, 1973b	Gr. 4 (Edmonton; N=60; High & Low SES)	-	-	.674*
	Gr. 4 (Orissa; N=90; High & Low SES)	-	-	.800*
Molloy, 1973	Low SES-Gr. 1 (n=30)	5.47	1.45	.762*#
	High SES-Gr. 1 (n=30)	5.80	1.21	.762*#
	Low SES-Gr. 4 (n=30)	9.13	1.50	.797*#
	High SES-Gr. 4 (n=30)	8.93	1.28	.797*#
Krywaniuk, 1974	Low Achievers-Gr. 3 (Hobema; n=38)	12.08	4.94	.711*
	Low Achievers-Gr. 3 (Edmonton; n=56)	11.89	6.93	.685*
	High Achievers-Gr. 3 (Edmonton; n=56)	14.09	6.41	.654*
Leong, 1974	Severely Disabled Readers ($\overline{CA}$=9-3 yrs.; n=58)	12.21	2.50	.694*
	Above Average Readers ($\overline{CA}$=9-3 yrs.; n=58)	14.55	2.02	.739*

* Simultaneous Factor Loading

# combined SES

Table 9 (Cont.)

Comparison of Means, Standard Deviations, and Factor Loadings of the Figure Copying Test

Authors	Groups	Means	SD	Factor Loadings
Jarman, 1975	Low IQ (Males, Gr. 4; N=60)	14.82	1.88	.767*
	Normal IQ (Males, Gr. 4; N=60)	14.55	2.46	.861*
	High IQ (Males, Gr. 4; N=60)	16.27	2.41	.483*
Kirby, 1976	Gr. 4 (Males, N=104)	13.60	2.92	.713*
	Gr. 4 (Females, N=98)	14.49	2.33	.629*
Williams, 1976	Learning Disabled (Gr. 2-6; N=51)	12.20	2.60	.866*

* Simultaneous Factor Loading

strategies was significantly more effective in concept formation than was merely presenting the tasks. On the basis of these findings, it is expected that training in the use of successive processing strategies will result in improved performance on cognitive tasks.

HYPOTHESIS 2(b): Within the Experimental group, improvement in performance on the successive and simultaneous marker tests after intervention will be greater for the "Below Average" group than for the "Average" group.

Previous research has shown that low achieving and learning disabled children are weak in sequential skills (e.g., Byran, 1972; Senf, 1969; Wirtenberg and Faw, 1975). Meier (1971) suggested that remedial training of these skills may be crucial. This was in line with Krywaniuk's (1974) research on low achievers. It would seem logical that if low achievers have more difficulty with tasks requiring sequential or verbal-successive skills than do average achievers, the low achievers should benefit more from training which stresses the use of successive strategies. Confirmation of Hypotheses 2(a) and 2(b) would be taken as a demonstration of the effectiveness of intervention.

HYPOTHESIS 3(a): After intervention, the number of children effectively using successive processing strategies will be greater for the Experimental group than for the Control group.

HYPOTHESIS 3(b): After intervention, the number of children in the Experimental group effectively using successive processing strategies will be greater for the "Below Average" group than for the "Average" group.

Hypotheses 2(a) and 2(b) deal with the response output portion of the Das _et al_. (1975) information processing model. Tests of the Primary Battery have consistently loaded on the successive or simultaneous processing factors, and are, by implication, measures of the individual's use of these strategies. Thus, by computing factor scores for each individual, based on median splits of successive and simultaneous factor scores, one can determine the degree to which the individual employs either successive or simultaneous processing. Previous research has shown intervention to be effective in improving output performance (Krywaniuk, 1974). It is assumed that in order to improve performance, the individual has also become more effective in the use of processing strategies. Confirmation of hypotheses 3(a) and 3(b) would be taken as a demonstration of the effectiveness of the intervention program and as confirmation of the supposition that internal information processing strategies can be taught.

HYPOTHESIS 4: Improvement in academic performance on the Metropolitan Achievement Test after intervention will be greater for the Experimental group than for the Control group.

Previous research has shown that training in strategies stressing successive or simultaneous information processing does transfer to academic learning situations. Krywaniuk (1974) found training in the verbal-successive strategy facilitated performance in word recognition. Hays and Pireira (1972) found training in visual and auditory memory facilitated improvement in reading achievement. It has been consistently demonstrated that children experiencing academic difficulties have deficient sequential processing skills (e.g., Krywaniuk, 1974; Leton, 1974; Meier, 1971). Cummins and Das (1977) demonstrated that successive processing correlates significantly with the reading and spelling subtests of the Wide Range Achievement Test. Children who have reading disabilities have also been found to have poor sequencing ability (e.g., Badian, 1977; Jesseau, 1974; Richie and Aten, 1976). Eakin and Douglas (1971) suggested that arithmetic achievement also relies on automatized sequential computational habits. On the basis of these findings, it is logical to expect that intensive training in the use of successive information processing strategies, and to a lesser extent in the use of simultaneous processing strategies, will transfer to academic performance. Confirmation of this hypothesis will be interpreted to mean that strategy training, within the framework of a theoretical information processing model, is a viable remedial technique.

CHAPTER V

INTERVENTION PHASE

The successive and simultaneous factors have been considered to reflect the strategies used by the individual in approaching the tasks of the Primary Test Battery. Thus, by implication, the tasks are measures of these strategies. Krywaniuk (1974) carried out an intervention program using tasks purporting to emphasize the use of successive strategies. However, although a task may be designed to emphasize a strategy, it is impossible, just from successful completion of the task alone, to determine the actual strategy used by a child. If the child is taught to verbalize his actions when attempting these tasks, one can at least partially monitor the strategy used. It is extremely difficult for a child to verbally order his actions and to visually or manually act in opposition (Jensen, 1966).

The present study was designed to examine the feasibility of training in the use of successive and, where necessary, simultaneous strategies, along with comprehensive and directive verbalization. The training tasks were not copies of the Primary Test Battery, nor did they include materials which were similar in content to the academic tasks in the MAT. Constant verbalization of actions, often prompted by the experimenters, was required of the child.

The tasks used in the intervention phase will be presented in a subsequent part of this chapter.

On the basis of MAT scores, the children were divided into "Average" and "Below Average" groups. Children were then randomly assigned to either the Control group or the Experimental group; thus, each group had an equal number (n=17) of "Average" and "Below Average" children. The Control group received no intervention, and was not seen, except in casual passing, by the experimenters during this phase.

The random assignment of the 34 children into the Experimental group resulted in fairly equal, and workable groups in terms of school placement. Table 10 presents the distribution of Experimental and Control subjects within the five classrooms. During the intervention phase, the author undertook all intervention at School B, which had 10 children in one classroom ('b^1') and seven in the other ('b^2'). The author's wife undertook all intervention in School A, which had eight children, and School C which had five children in one classroom ('c^1') and four children in the other ('c^2').

Schedule For Intervention Phase

Intervention began in mid-January, 1977 and continued until late May, 1977, involving 17 weeks of intervention. During this time, the children had one week-long break from

Table 10

Distribution of Experimental and Control Subjects Within the 5 Grade Four Classrooms

	SCHOOLS					
	A	B		C		
CLASSROOMS	a	b^1	b^2	c^1	c^2	Total in Each Group
EXPERIMENTAL GROUP	8	10	7	5	4	34
(Males)	(4)	(6)	(5)	(3)	(3)	(21)
(Females)	(4)	(4)	(2)	(2)	(1)	(13)
CONTROL GROUP	11	5	6	7	5	34
(Males)	(6)	(3)	(2)	(2)	(3)	(16)
(Females)	(5)	(2)	(4)	(5)	(2)	(18)
Total in Each School	19	15	13	12	9	68

school during which there was no intervention. In cases where there were other school holidays, e.g., Teacher's Convention, the children were seen on another day during the same week. The author worked with nine of the 10 children in classroom 'b^1' on Mondays, and one child from classroom 'b^1' and the seven children from classroom 'b^2' on Wednesdays. The author's wife worked with the eight children from classroom 'a' on Tuesdays and the nine children from classroom 'c^1' and 'c^2' on Thursdays. These days were chosen on the basis of teacher preference, and the days devoted to each class were not changed, except for those weeks when there were school holidays, in order to accomodate the teachers as far as possible. Each child was seen individually for 35 minutes each week. Thirty-five minute periods were chosen as the optimal amount of time which could be spent with each child, based on the total number of children per class and the time available to the two experimenters. Initial ordering of the children in each classroom was random. Subsequently, the children were systematically rotated in this order to ensure their being seen at different times on the same day each week. The child from classroom 'b^1' who was seen on the same day as the children from classroom 'b^2' was also selected in this manner. In instances where a child was absent, he or she was seen on the day of his/her arrival back at school, after confirmation of attendance by telephone. Such occurences were fortunately rare.

In this manner, each child received a total of 10 hours of intervention.

All intervention was conducted in the school nurse's office in each school. Since the schools are identical, all intervention milieu were similar, if not identical. In all cases, the children were comfortably seated at a large desk in a well lit room. Each child, as he/she left the session, was asked to have the next child, named by the experimenter, to come to his/her session. This allowed the experimenter time to prepare the task for the next child, and resulted in very little wasted time.

An intervention summary booklet was assigned for each child. In this, the experimenter noted any errors the child had made, time needed to complete tasks, where relevant, and directly required verbalizations (e.g., task titles) where relevant. The intervention tasks, to be subsequently described, were randomly ordered for each child prior to the start of intervention. Exceptions to this random order were the first task, which was given to each child as his/her first task, the last task, which was a readministration of the first task, and the filmstrips, which were given in the order designated by the distributor. A filmstrip was given in the same order to each child after his/her first, fourth, sixth, seventh, ninth, tenth, and thirteenth tasks. In addition, the tasks involving matrices, while not given at the same time to each child, were always given in the order of MATRIX NUMBERS, MATRIX LETTERS, then MATRIX PICTURES to each child, since each subsequent task builds on the ones previous to it (Dornbush, 1968). Similarly, serial recall always preceded free recall, since the pictures in serial recall were pairs of complementary items, while the pictures in free recall were of items which could be grouped according to similarity and thus required a developmentally higher level of categorization (Denney, 1974).

A major part of the intervention was teaching the child to verbalize his actions. During each session, the child was encouraged to verbalize the strategies and give a verbal summary. At the beginning of each session, the child was asked, through directive questioning, to summarize the strategies used in previous sessions, e.g., giving a specific title to provide a complete overview. In addition, items in any one task were approximately equally spaced during each child's session depending upon the time, i.e., trials, the child needed to complete the first item. When a child finished an item quickly, i.e., completed it correctly in one trial, more time was spent between tasks with the experimenter having the child verbally summarize what had happened on this and previous tasks. Thus, the total time spent by each child on any one task (and concurrent verbalization) was 35 minutes.

The tasks will be described in the order in which they are presented in the intervention summary booklet, and will be numbered according to that order; Appendix I presents examples of some of the tasks. However, as was previously stated, the order of presentation of tasks to each child varied. The tasks used in the intervention were all derived from existing sources, but were modified by the author to facilitate the teaching of successive and simultaneous strategies. While choosing the tasks, a further consideration was that they should be of interest to the child. By these means, the author was able to ensure, as far as was possible, that these strategies were indeed used. The successive strategy was emphasized in all tasks, and where the task lent itself, concurrent secondary emphasis was also given to the simultaneous strategy. The important feature in all tasks was the verbalization and concomitant action elicited from the child.

Intervention Tasks

Task 1: PEOPLE PUZZLES (DLM)

PEOPLE PUZZLES consisted of four 8½" x 11" colored picture puzzles of people: A facial view of a toddler boy; a young teen-aged boy in full view; a facial view of a man; and a facial view of a woman. Rather than being true jig-saw puzzles, these puzzles were composed of horizontal strips which extended the full width, one-half the width, or one-third of the width of the puzzle. This made the puzzle more amenable to sequential attack, e.g., top to bottom. Each puzzle picture was on a solid background of a different color, and the back of each puzzle was composed of a different green design on a white background, i.e., green vertical lines, green checkered lines, green dots, and green horizontal lines, respectively. In addition, the upper side of each puzzle had a solid line, of a different color from the background color, along the extreme right hand side.

The task was timed, after familiarizing and desensitizing the child to the stop watch. Initially, all pieces from all four puzzles were mixed together in a large envelope. The child's task was to put together the puzzles, one at a time.

Step 1: The experimenter said to the child: "IN THIS ENVELOPE THERE ARE FOUR PEOPLE PUZZLES. THE PIECES ARE ALL MIXED UP. WHEN I DUMP THE PIECES IN FRONT OF YOU, I WANT YOU TO WORK QUICKLY, AND PUT TOGETHER ONE OF THE PUZZLES.

JUST PUT TOGETHER THE PUZZLE OF THE YOUNGEST BOY." [No mention was made of what the other three puzzles were.] "DO YOU UNDERSTAND WHAT YOU ARE TO DO?" [Pause.] "TELL ME WHAT YOU ARE GOING TO DO." [If the child was unable to verbalize what he/she was to do, the instructions were repeated.]

Step 2: The experimenter gave the pieces to the child by turning the envelope upside down, close to the child's working surface in order that the pieces remained in a pile. Once the pieces were out of the envelope, they were not disturbed by the experimenter.

Step 3: Immediately after the pieces were available to the child, the experimenter said, "WORK AS QUICKLY AS YOU CAN, AND PUT TOGETHER JUST THE PUZZLE OF THE YOUNGEST BOY...BEGIN." The stopwatch was then started by the experimenter.

Step 4: For the first puzzle, the experimenter merely observed and recorded the child's immediate strategy, i.e., separation of pieces into front color, back design or people-picture, or no apparent strategy. The time required for the child to complete the puzzle was recorded. If the child did not begin with the puzzle of the youngest boy, the experimenter stopped the child and, through questioning, had the child verbalize the meaning of "youngest," as opposed to "smallest," since occasionally a child was confused by the difference in size of facial features between the two puzzles of boys. Once the child had the meaning

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clear, he/she was allowed to continue. In this case, the stopwatch was started when the child began after clarification of meaning.

Step 5: Once the child had completed the puzzle correctly, the experimenter pointed to the puzzle and asked "HOW ARE THESE PIECES THE SAME?" For those children who initially separated the pieces into piles, a response of "front-color, back-design or people picture" was generally immediate. For those children who did not respond immediately or who did not use any apparent initial strategy, the experimenter elicited these responses through directive questioning. Each child had verbalized awareness of similarity of front-color and back-design before the task was continued.

Step 6: If the child put the puzzle together incorrectly, the experimenter working with the child, began at the top of the puzzle and worked down, saying, and rearranging where necessary, "FIRST THIS, SECOND THIS, THIRD THIS," etc., having the child verbalize the part of the face involved each time. If one of the horizontal pieces was divided in one-half or one-third, the left-hand side was pointed to first, saying "FOURTH THIS," then the right-hand side was pointed to saying "AND FIFTH THIS." After the necessary corrections were made, the child was asked, "IN WHAT WAY ARE THESE PIECES THE SAME?", following the format indicated in Step 5.

Step 7: The experimenter then scooped up the pieces and mixed them with the other puzzle pieces to make a pile.

The experimenter then said, "AGAIN, WORK AS QUICKLY AS YOU CAN, AND PUT TOGETHER THE PUZZLE OF THE OLDER BOY. DO YOU UNDERSTAND? TELL ME WHAT YOU ARE GOING TO DO." [The child had to verbalize the instructions.]

Step 8: The experimenter started the stopwatch and observed and recorded the child's immediate strategy. When the child had completed the puzzle, the time was recorded.

Step 9: Step 5 was repeated. Step 6 was then repeated for all children, and the experimenter pointed out the usefulness of systematic attack.

Step 10: The experimenter used directive questioning to elicit awareness of the line along the right hand side, and awareness of the usefulness of this line in orienting the pieces.

Step 11: The experimenter again scooped all the pieces together to make one pile. The child was again asked to verbalize the usefulness of front-color and back-design. The experimenter then said, "AGAIN, WORK AS QUICKLY AS YOU CAN, AND NOW PUT TOGETHER THE PUZZLE OF THE MAN. DO YOU UNDERSTAND? TELL ME WHAT YOU ARE TO DO."

Step 12: Step 8, Step 5, and Step 6 were repeated. If the child did not use either front-color or back-design to find all the pieces, it was suggested that he/she do so. Similarly, systematic, top-to-bottom, left-to-right attack was suggested.

Step 13: The experimenter again scooped all the pieces together to make one pile. The child was again asked to verbalize the attack to be used. The experimenter than said, "AGAIN, WORK AS QUICKLY AS YOU CAN, AND NOW PUT TOGETHER THE PUZZLE OF THE WOMAN. DO YOU UNDERSTAND? TELL ME WHAT YOU ARE TO DO."

Step 14: Step 8, Step 5 and Step 6 were repeated. The experimenter asked the child what had been learned. Through directive questioning, the child was asked to verbalize the usefulness of peripheral or secondary clues in completing a task. Many of the children verbalized the feeling that use of such clues was "cheating." It was emphasized that in the long run, solutions can be arrived at easier by systematic, efficient use of all available clues.

The PEOPLE PUZZLES task was repeated for all children as the last task. The procedure used was the same as that used for the first administration.

Task 2: PICTURE STORY ARRANGEMENT

PICTURE STORY ARRANGEMENT consisted of seven series of pictures, the first three series being on 2-3/4" x 2¼" hard-backed cards, the last four series being on 4" x 4" squares of paper. The first three series came from LETS LEARN SEQUENCE (INSTRUCTO). The last four series are part of SEQUENTIAL STRIPS (DLM). The first series consisted of three cards, while the other six series consisted of six cards each. Each series depicted a complete story. In each series, the author had numbered each card in the sequence they were to be presented to the child, and had letter coded each card according to the correct response, in the same manner as that used in the WISC-R Picture Arrangement subtest (Wechsler, 1974). The series were ordered according to probable degree of difficulty, beginning with the easiest and ending with the most difficult. The child's task was to order each of the series into sensible stories.

Step 1: The experimenter said to the child: "THESE CARDS ALL HAVE PICTURES WHICH TELL A STORY. I AM GOING TO PUT THE PICTURES IN FRONT OF YOU IN THE WRONG ORDER. I WANT YOU TO PUT THE PICTURES INTO THE RIGHT ORDER SO THAT THE STORY MAKES SENSE. HOWEVER, BEFORE YOU BEGIN TO REARRANGE THE PICTURES, I WANT YOU TO LOOK AT THE PICTURES, THEN MAKE UP A TITLE FOR THE STORY, WHICH WILL DESCRIBE WHAT IS HAPPENING IN THE STORY. AFTER YOU TELL ME THE TITLE YOU HAVE CHOSEN, I WILL TELL YOU TO BEGIN TO REARRANGE THE PICTURES. AS YOU PUT THE PICTURES INTO THE RIGHT ORDER, I WANT YOU TO SAY 'FIRST THIS, SECOND THIS,' AND SO ON, TELLING ME WHAT IS GOING ON IN THE PICTURE EACH TIME. DO YOU UNDERSTAND? TELL ME WHAT YOU ARE TO DO." [If the child was unable to verbalize what he/she was to do, the instructions were repeated.]

Step 2: The first series of cards were placed in front of the child. After the child had verbalized a title, he/she was told to begin. If the child did not verbalize his/her arrangement in the manner "FIRST...SECOND...," etc., the experimenter asked the child to do so. When the child had completed the task, the experimenter noted the order of recall.

Step 3: The experimenter asked the child how well the title he/she had chosen had described the story, then asked the child if he/she could think of a more comprehensive title. Through directive questioning, the child was guided into verbalizing the usefulness of ordering actions through verbalization.

Step 4: If the child's arrangement of the pictures was incorrect, the experimenter recorded the response, then picked up the pictures and put them down again in the original order. The child was asked to chose a different title or to elaborate upon his/her original title. The child again was asked to put the pictures in the right order so that the story made sense.

Step 5: Step 4 was repeated until the child's solution was correct.

Step 6: Steps 2 through 6 were repeated for each of the other series. In the final four series, the child was asked, through directive questioning, to notice valuable secondary clues which would aid in correct sequencing of more difficult stories, e.g., changes in sky color at sunrise, changes in time on a wall clock.

Step 7: At the completion of the task, the child was asked to summarize what had been done, focusing on the usefulness of titling and of verbalizing successive actions.

Task 3: MATRIX NUMBERS

This task consisted of four items. Each item was a five-cell matrix which had one number per cell. Numbers were chosen randomly, but so that no one number appeared more than once in any one cell. Each matrix was presented in the shape of a cross, with one central cell, and one cell on each of its sides. The task is similar to one used by Krywaniuk (1974), but with some modifications.

Each matrix in the present task was presented on white sheets of 8½" x 11" paper. The matrix was placed on the centre of the paper, with each cell being one inch square. In each case, the child was shown a complete matrix, containing one digit in each cell. Thereafter, the child was shown the matrix broken down into its five component parts, with each part being presented separately on a single page, but in its correct position on an otherwise empty matrix. In this way, the child was taken sequentially through the matrix. After he/she had viewed the entire matrix, then the five component parts separately, he/she was asked to recall and write down the complete matrix on a sixth, blank matrix. The sixth page was covered with an acetate sheet upon which the child wrote with a washable marker. After each completed response, the sheet was wiped off with a damp sponge.

Each child's response, and cell-order of each response were recorded by the experimenter.

Step 1: The experimenter said, "I AM GOING TO SHOW YOU A GROUP OF NUMBERS. AFTER YOU HAVE STUDIED THE NUMBERS, I WILL ASK YOU TO WRITE THEM DOWN IN THE SAME POSITION IN WHICH YOU SAW THEM. AS I SHOW YOU THE NUMBERS, I WANT YOU TO POINT TO AND SAY THEM ALOUD, SAYING 'FIRST THIS, SECOND THIS,' AND SO ON, NAMING THE NUMBER EACH TIME." [As this was said, the experimenter indicated the sequence to be followed, using the first matrix.] "DO YOU UNDERSTAND? TELL ME WHAT YOU ARE TO DO." [If the child was unable to verbalize what he/she was to do, the instructions were repeated.]

Step 2: The child was shown the first matrix, and was allowed to view it for five seconds. Following this, the child was asked to verbalize each number, in sequence, saying "first.., second..," etc. The experimenter guided the child where necessary by pointing to each number and/or initiating expected verbalization.

Step 3: The experimenter turned the remaining stimulus cards for the first matrix, in order, and guided the child into saying, "FIRST IS THE NUMBER ___," for the first card; "SECOND IS THE NUMBER __," for the second card, and so on for all five cards.

Step 4: The child was presented with the blank matrix, and was asked to recall and write in the numbers to complete the matrix.

Step 5: If the child recalled the matrix incorrectly, Step 2, Step 3, and Step 4 were repeated until the child correctly recalled the matrix. The child's response and cell-order were recorded each time.

Step 6: The other three matrices were presented, following the format in Step 2, Step 3 and Step 4 and, where necessary, Step 5. If he/she was not doing so, the child was asked to try to recall the numerals in the order presented. Through directive questioning, the child was asked to verbalize the usefulness of consistent search and recall patterns.

Step 7: At the completion of the task, the child was asked to summarize what had been done, focussing on the usefulness of verbalization and a consistent search and recall pattern as mnemonic devices.

Task 4: MATRIX LETTERS

This task was similar, and was presented in the same manner as MATRIX NUMBERS. The task consisted of four items. Each item was a five-cell matrix which had one letter per cell. However, letters were not chosen randomly, although no one letter appeared more than once throughout the four matrices. Letters were chosen so that the top and far left letter could be grouped, and the middle and the far right letter could be grouped. Generally, the groupings were standard abreviations (e.g., PS). The bottom (and final) letter of each matrix was the only vowel in the matrix, and as such, could be a word, or phonetically associated to a word (e.g., U-you).

Once again, the child's response, and cell order of each response were recorded by the experimenter.

Step 1: The experimenter said, "I AM GOING TO SHOW YOU A GROUP OF LETTERS. THIS TASK IS SIMILAR TO THE ONE YOU DID USING NUMBERS. AFTER YOU HAVE STUDIED THE LETTERS, I WILL ASK YOU TO WRITE THEM DOWN IN THE SAME POSITIONS IN WHICH YOU SAW THEM. AS I SHOW YOU THE LETTERS, I WANT YOU TO POINT TO THEM AND TO SAY THE LETTER NAMES ALOUD, SAYING 'FIRST__, SECOND __,' AND SO ON, NAMING THE LETTER EACH TIME. [As this was said, the experimenter indicated the sequence to be followed, using the first matrix.] DO YOU UNDERSTAND? TELL ME WHAT YOU ARE TO DO." [If the child was unable to verbalize what he/she was to do, the instructions were repeated.]

Step 2: The child was shown the first matrix and was allowed to view it for five seconds. Following this, the child was asked to verbalize the name of each letter, saying "first..., second...," etc. The experimenter guided the child where necessary by pointing to each letter and/or initiating expected verbalization.

Step 3: The experimenter turned the remaining stimulus cards for the first matrix, in order, and guided the child into saying, "FIRST IS THE LETTER _," for the first card; "SECOND IS THE LETTER __," for the second card, and so on for all five cards.

Step 4: The child was presented with the blank matrix and was asked to recall and write in the letters to complete the matrix.

Step 5: If the child recalled the matrix incorrectly, Step 2, Step 3 and Step 4 were repeated until the child correctly recalled the matrix. The child's response and cell order were recorded each time.

Step 6: Once the child had correctly recalled the first matrix and had established search and recall sequence, his/her attention was called to the facility of the letters to grouping. The child was asked to verbalize the groupings, giving the appropriate cadence, i.e., da-da, da-da, da. Through directive questioning, the child was asked to verbalize the associations of the groupings, and the fact that now only three, as opposed to five, chunks of information had to be remembered.

Step 7: The second matrix was presented to the child, and after viewing it for five seconds, he/she was asked to verbalize the letters in sequence following the grouping cadence of "da-da, da-da, da." [The child was NOT asked to verbalize first..., second..., etc.]

Step 8: The experimenter turned the remaining cards for the first matrix in order, and guided the child, partially by speed of presentation, into saying the letters in groups.

Step 9: The child was presented with the blank matrix and was asked to recall and write in the letters to complete the matrix.

Step 10: If the child recalled the matrix incorrectly, Step 6, Step 7, Step 8 and Step 9 were repeated until the child correctly recalled the matrix.

Step 11: The final two matrices were presented using the format of Step 7, Step 8, Step 9 and, where necessary, Step 10.

Step 12: At the completion of the task, the child was asked to summarize what had been done, focussing on the usefulness of verbal rehearsal, a consistent search and recall pattern, grouping and association as mnemonic devices.

Task 5: MATRIX PICTURES

This task was similar to MATRIX NUMBERS and MATRIX LETTERS. The task consisted of four items. Each item was a five-cell matrix which had one stimulus per cell. Three of the stimuli were pictures, one stimulus was a design, from the same set of cards as the pictures, and the fifth stimulus was a letter, printed by the author on the background card in block, filled-in letters. The pictures and designs were taken from MEMORY GAME (INSTRUCTO). Each 2" x 2" card was of heavy cardboard, and was mounted on a background 2½" x 2½" card of light brown cardboard. The matrices were presented on reinforced white 8½" x 11" paper. The pictures, design, and letter were different for each matrix, and were arranged so that neither the design nor the letter appeared more than once in any one cell.

Step 1: The experimenter said to the child, "I AM GOING TO SHOW YOU A GROUP OF PICTURES. THIS TASK IS SIMILAR TO THE ONES HAVING NUMBERS AND LETTERS. AFTER YOU HAVE STUDIED THEM, I WILL ASK YOU TO RECALL THE PICTURES IN THE SAME POSITIONS IN WHICH YOU SAW THEM. AS I SHOW YOU THE PICTURES, I WANT YOU TO POINT TO THEM AND NAME THEM ALOUD, SAYING 'FIRST __, SECOND __,' AND SO ON, NAMING THE PICTURE EACH TIME. [As this was said, the experimenter indicated the sequence to be followed, using the first matrix.] DO YOU UNDERSTAND? TELL ME WHAT YOU ARE TO DO." [If the child was unable to verbalize what he/she was to do, the instructions were repeated.]

Step 2: The child was shown the first matrix, and was allowed to view it for five seconds. Following this, the child was asked to verbalize the name of each picture, using the word of his/her choice for pictures and the design, and saying, "FIRST IS __, SECOND IS __," etc. The experimenter guided the child where necessary by pointing to the picture.

Step 3: The experimenter pointed out to the child that the matrix parts could be associated in sequence by making up stories to fit. As an example for the first matrix, the experimenter said, "THE BIRD (first picture) IS GOING TO CHECK (second picture, a design) THE GOOSE (third picture) AND THE HORSE (fourth picture) WHO SAYS EEE (fifth picture, the letter E).

Step 4: The child is asked to look at the matrix again, and to repeat the experimenter's story as he/she points to each card.

Step 5: The experimenter turned the remaining stimulus pages for the first matrix, in order, and guided the child into repeating the story.

Step 6: The child was presented with the blank matrix and was asked to recall the pictures and point to the appropriate cells to complete the matrix.

Step 7: If the child recalled the matrix incorrectly, Step 2, Step 3, Step 4, Step 5 and Step 6 were repeated until the child correctly recalled the matrix. The child's response and cell-order were recorded each time.

Step 8: The remaining three matrices were presented using the format of Step 2, Step 3, Step 4, Step 5, Step 6, and where necessary, Step 7. However, on these matrices, the child was guided into verbalizing his/her own story to fit the sequence of the matrix in question.

Step 9: At the completion of the tasks, the child was asked to summarize what had been done, focussing on the usefulness of verbal rehearsal, a consistent search and recall pattern, and overall association as mnemonic devices.

Task 6: PICTURE (NUMBER) ARRANGEMENT

This task consisted of 12 series of pictures, presented three series to a card on four cards. The 8½" x 5½" cards are from MEMORY TASKS FOR READING (WISE OWL), and were covered with clear acetate sheets so that after completion by each child, responses made with a washable marker could be erased with a damp sponge.

Each series was lettered and consisted of four 1½" x 7/8" black-and-white pictures, spaced 3/8" apart, which, when properly arranged would depict a story or sequence. Under each picture was a blank ½" line on which the child could write a number, depicting the order of that particular picture in the story. To facilitate scoring, the author had placed a duplicate card on the back side, putting in the correct sequencing in the blank spaces. The child's task was to number the pictures in each series so that the order depicted a sensible story.

Step 1: The experimenter placed the first card in front of the child, saying, "I WANT YOU TO NUMBER EACH OF THE PICTURES IN THESE SETS [pointing to each series] SO THAT THEY ARE IN THE CORRECT ORDER TO MAKE A SENSIBLE STORY. HOWEVER, BEFORE YOU BEGIN, I WANT YOU TO MAKE UP A TITLE FOR THE STORY. LOOK AT THE PICTURES AND TELL ME WHAT YOU THINK THE TITLE SHOULD BE." [The child's title for each series was recorded by the experimenter.]

Step 2: The experimenter said to the child, "NOW, I WANT YOU TO NUMBER THESE PICTURES IN ORDER SO THAT THE STORY MAKES SENSE. AS YOU WRITE IN THE NUMBERS, SAY 'FIRST THIS, SECOND THIS, THIRD THIS, AND FOURTH THIS,' TELLING WHAT IS HAPPENING IN THE PICTURE EACH TIME. DO YOU UNDERSTAND? TELL ME WHAT YOU ARE TO DO." [If the child was unable to verbalize what he/she was to do, the instructions were repeated.]

Step 3: The experimenter said, "HERE IS THE MARKER. BEGIN.".

Step 4: If the child did not verbalize the picture contents, saying "first, second," etc., he/she was asked to do so.

Step 5: When the child had completed the task, the sequence of responses were recorded.

Step 6: If the child's response was incorrect, he/she was asked to choose a more encompassing, or a more appropriate title. The experimenter then said, "NUMBER THE PICTURES OF THIS STORY AGAIN. WHILE YOU ARE NUMBERING, REMEMBER TO SAY 'FIRST THIS, SECOND THIS, THIRD THIS AND FOURTH THIS,' TELLING WHAT IS HAPPENING IN THE PICTURE EACH TIME. ARE YOU READY? BEGIN."

Step 7: Series two through 12 were presented using the format of Steps 1, 2, 3, 4, 5, and, where necessary, Step 6.

Step 8: After completion of the task, the child was asked to summarize what had been done, focussing on the usefulness of both a comprehensive title and verbalization in the organization of thoughts to complete a sequential task.

Task 7: SERIAL RECALL OF PICTURES

This task consisted of five items. The first item was composed of six cards, while the last four items were composed of 10 cards each. Each 2½" x 2½" card was of light brown cardboard, and each had a different black-and-white picture of an object or person affixed in the centre. These pictures (approximately ½" x 1") were from cards found in MEMORY TASKS FOR READING (WISE OWL), which were cut apart and used in an order devised by the author. Each series of cards was composed of pictures of objects that could be paired (e.g., a key and a lock), so that the first series contained three pairs and the other four series contained five pairs. Objects were arranged so that one item from each pair was in the first half of each series while the other item from each pair was in the identical order in the second half of the series. Each card in a series was numbered, and the object was named, on the back in the order in which they were to be placed in front of the child. The child's task was to recall, in serial order, all of the pictures in each series.

Step 1: The experimenter showed the stack of cards in the first series to the child, saying, "HERE ARE A GROUP OF PICTURES. I AM GOING TO PLACE THEM IN FRONT OF YOU, AND AFTER YOU HAVE STUDIED THEM, I WILL REMOVE THE PICTURES AND

THEN ASK YOU TO RECALL THEM ALL. AS I PLACE EACH PICTURE BEFORE YOU, I WANT YOU TO NAME IT ALOUD, SAYING 'FIRST __, SECOND __,' AND SO ON, NAMING THE PICTURE EACH TIME. ONCE ALL OF THE PICTURES ARE IN FRONT OF YOU, I WANT YOU TO GO THROUGH THEM ONCE AGAIN, SAYING 'FIRST __, SECOND _ ,' AND SO ON. DO YOU UNDERSTAND? TELL ME WHAT YOU ARE TO DO." [If the child was unable to verbalize what he/she was to do, the instructions were repeated.]

Step 2: The experimenter then placed each card from the first series side-by-side in front of the child. If the child failed to verbalize, he/she was asked to do so. If he/she could not think of a word, the experimenter provided assistance.

Step 3: After the child had viewed the items for a maximum time of two seconds per card, the cards were sequentially removed, beginning with the first card placed in front of the child. If the child did not rehearse the pictures verbally, he/she was asked to do so.

Step 4: The child was asked to recall the pictures, and the experimenter recorded the order of recall.

Step 5: Regardless of whether the child's response was correct or incorrect, the cards from the first series were again presented to the child. The experimenter, through directive questioning, asked the child to verbalize the inclusion of items which could be paired, and the ordering of pairs in the series. The cards were then picked up by the experimenter. The experimenter said to the child, "I AM GOING TO ASK YOU TO STUDY THESE PICTURES AGAIN, AND AFTER I HAVE REMOVED THE PICTURES, I WILL AGAIN ASK YOU TO RECALL THEM ALL. HOWEVER, THIS TIME, YOU CAN RECALL TOGETHER THE OBJECTS WHICH CAN BE PAIRED, BUT I WOULD LIKE YOU TO TRY TO RECALL THE PAIRS IN THE ORDER IN WHICH THE FIRST ITEM OF THAT PAIR WAS GIVEN. THUS, FOR THIS SET OF PICTURES, THE ORDER FOR RECALL WOULD BE 'KEY-LOCK, BRUSH-PAINTS, LIGHTBULB-SWITCH.' IF YOU WOULD RATHER, YOU CAN STILL RECALL ALL THE ITEMS IN THE ORDER THEY WERE GIVEN, USING THE PAIRED ASSOCIATIONS TO HELP YOU REMEMBER ALL THE ITEMS AND THEIR ORDER IN THE SERIES. DO YOU UNDERSTAND? TELL ME WHAT YOU ARE TO DO." [If the child was unable to verbalize what he/she was to do, the instructions were repeated.]

Step 6: The experimenter then placed each card from the first series side-by-side in front of the child. If the child failed to verbalize and rehearse items or pairs of items, he/she was asked to do so.

Step 7: After the child had viewed the items for a maximum time of two seconds per card, the cards were sequentially removed, beginning with the first card placed in front of the child.

Step 8: The child was asked to recall the pictures and the experimenter recorded the order of recall.

Step 9: If the child was unable to recall the pictures in total, or in one of the orders requested, Steps 6, 7, and 8 were repeated.

Step 10: The experimenter then placed each card from the second series side-by-side in front of the child, saying, "AS I PLACE EACH PICTURE BEFORE YOU, I WANT YOU TO NAME IT ALOUD, SAYING 'FIRST __, SECOND __' AND SO ON, NAMING THE PICTURE EACH TIME." Once all the pictures were in front of the child, the experimenter asked the child which method of recall he was going to use. If the child indicated recall of ordered pairs, the experimenter said, "I WANT YOU TO GO THROUGH THE PICTURES AGAIN, REHEARSING THE NAME OF EACH PAIR OF ITEMS ALOUD IN THE ORDER IN WHICH THE FIRST ITEM OF THAT PAIR WAS GIVEN, AS YOU DID WITH THE LAST SET OF PICTURES. BE SURE TO REPEAT THE NAMES OF THE PAIRS ALOUD AS OFTEN AS YOU CAN. ALSO BE SURE TO COUNT THE NUMBER OF PAIRS. YOU MIGHT TRY CHECKING OFF A FINGER OF ONE HAND IN ORDER, AS YOU REHEARSE EACH PAIR, SINCE THIS WILL HELP YOU TO ASSOCIATE AND RECALL BETTER. DO YOU UNDERSTAND? TELL ME WHAT YOU ARE TO DO." [If the child was unable to verbalize what he/she was to do, the instructions were repeated.] If the child indicated recall of pictures in the order presented, the experimenter said, "I WANT YOU TO GO THROUGH THE PICTURES AGAIN, REHEARSING THE NAME OF EACH PICTURE ALOUD IN THE ORDER IN WHICH THEY WERE PRESENTED. BE SURE TO REPEAT THE NAMES OF THE PICTURES ALOUD AS OFTEN AS YOU CAN. ALSO BE

SURE TO COUNT THE NUMBER OF PICTURES. YOU MIGHT TRY CHECKING OFF A FINGER AS YOU REHEARSE EACH PICTURE, SINCE THIS WILL HELP YOU TO ASSOCIATE AND RECALL BETTER. DO YOU UNDERSTAND? TELL ME WHAT YOU ARE TO DO." [If the child was unable to verbalize what he/she was to do, the instructions were repeated.]

Step 11: Step 7 and Step 8 were repeated.

Step 12: If the child was unable to recall the pictures in total, or in one of the orders requested, Step 10 was repeated, using the instructions for the method of recall used by the child for the first administration of that series. Steps 7 and 8 were then repeated. This was done to a maximum of four trials per series of pictures.

Step 13: Steps 10, 7, 8, and where necessary, Step 12 were repeated for the remaining three series of pictures.

Step 14: At the completion of the task, the child was asked to summarize what had been done, focussing on the usefulness of verbal rehearsal and association of parts in serial recall.

Task 8: FREE RECALL OF PICTURES

This task consists of six items. The first two items were composed of six cards, the following two items were composed of eight cards, the fifth item was composed of 10 cards, and the sixth item was composed of 12 cards. Each 2½" x 2½" card was of light brown cardboard, and each had a different black-and-white picture of an object or person affixed in the centre. These pictures (approximately ½" x 1") were from cards found in MEMORY TASKS FOR READING (WISE OWL), which were cut apart and used in an order devised by the author. In the first series, all pictures belonged to the same category, i.e., sweets or desserts. In each of the other series, pictures could be equally distributed into two categories. In these series, the items were arranged so that an item from one category was always followed by an item from the other category. Items were arranged in this way to facilitate ease of reorganization by the child into groups, i.e., items from one category could be moved up and pushed together while items of the second category could be left in the line presented and pushed together. The categories were different for each series. Each card in a series was numbered, and the object named, on the back in the order in which they were to be placed in front of the child. The child's task was to recall, in any order, all of the pictures in each series.

Step 1: The experimenter showed the stack of cards in the first series to the child, saying, "HERE ARE A GROUP OF PICTURES. I AM GOING TO PLACE THEM IN FRONT OF YOU, AND AFTER YOU HAVE STUDIED THEM, I WILL REMOVE THE PICTURES AND THEN ASK YOU TO RECALL THEM ALL. AS I PLACE EACH PICTURE BEFORE YOU, I WANT YOU TO NAME IT ALOUD. ONCE ALL THE PICTURES ARE IN FRONT OF YOU, I WANT YOU TO GO THROUGH THEM

AGAIN, REHEARSING THE NAMES ALOUD TO YOURSELF IN ANY ORDER YOU CHOOSE. DO YOU UNDERSTAND? TELL ME WHAT YOU ARE TO DO." [If the child was unable to verbalize what he/she was to do, the instructions were repeated.]

Step 2: The experimenter then placed each card from the first series side-by-side in front of the child. If the child failed to verbalize, he/she was asked to do so. If he/she could not think of a word, the experimenter provided assistance.

Step 3: After the child had viewed the items for a maximum time of two seconds per card, the cards were sequentially removed, beginning with the first card placed in front of the child. If the child did not rehearse pictures verbally, he/she was asked to do so.

Step 4: The child was asked to recall the pictures and the experimenter recorded the order of recall, although the child was allowed to recall the pictures in any order.

Step 5: Regardless of whether the child's response was correct or incorrect, the cards from the first series were again presented to the child. The experimenter, through directive questioning, asked the child to verbalize the fact that all items could be included in one category. The experimenter said, "I AM GOING TO ASK YOU TO STUDY THESE PICTURES AGAIN, AND AFTER I HAVE REMOVED THE PICTURES, I WILL AGAIN ASK YOU TO RECALL THEM ALL IN ANY ORDER. AS YOU REHEARSE THE NAMES OF THE PICTURES ALOUD, IN ANY ORDER YOU

WISH, YOU MIGHT TRY CHECKING OFF A FINGER AS YOU REHEARSE EACH PICTURE, SINCE THIS WILL HELP YOU TO ASSOCIATE AND RECALL BETTER. BE SURE TO COUNT THE TOTAL NUMBER OF PICTURES TO BE RECALLED EACH TIME. DO YOU UNDERSTAND? TELL ME WHAT YOU ARE TO DO." [If the child was unable to verbalize what he/she was to do, the instructions were repeated.]

Step 6: Steps 3 and 4 were repeated.

Step 7: If the child was unable to recall all the pictures, Steps 5, 3 and 4 were repeated to a maximum of four trials.

Step 8: The experimenter placed each card from the second series side-by-side in front of the child, asking the child to verbalize the name of the picture as each was presented. If he/she could not think of a word, the experimenter provided assistance.

Step 9: Through directive questioning, the child was asked to verbalize the facts that items could be included in one of two categories, and that items were ordered alternately according to categories.

Step 10: The experimenter said, "I WANT YOU TO STUDY THESE PICTURES, AND AFTER I HAVE REMOVED THEM, I AM GOING TO ASK YOU TO RECALL ALL THE PICTURES IN ANY ORDER. YOU CAN GROUP THE PICTURES INTO CATEGORIES TO HELP YOU REMEMBER THEM BY MOVING THE ITEMS FROM ONE CATEGORY UP INTO ANOTHER LINE, AND CLOSING THE LINES TOGETHER. [As this was said, the experimenter demonstrated.] AGAIN, YOU MUST BE SURE TO COUNT THE TOTAL NUMBER OF PICTURES TO BE RECALLED. AS YOU REHEARSE THE NAMES OF THE PICTURES ALOUD, IN ANY ORDER YOU WISH, YOU MIGHT TRY CHECKING OFF A FINGER AS YOU REHEARSE EACH PICTURE, SINCE THIS WILL HELP YOU TO ASSOCIATE AND RECALL BETTER. DO YOU UNDERSTAND? TELL ME WHAT YOU ARE TO DO." [If the child was unable to verbalize what he/she was to do, the instructions were repeated.]

Step 11: Step 3 and Step 4 were repeated.

Step 12: If the child was unable to recall all the pictures, Steps 10, 3 and 4 were repeated to a maximum of four trials.

Step 13: Steps 2, 3, 4, and where necessary, Step 12 were repeated for the remaining four series of pictures.

Step 14: At the completion of the task, the child was asked to summarize what had been done, focussing on the usefulness of verbal rehearsal, categorization, and overt grouping in free recall.

Task 9: FOLLOW-THE-ARROWS

This task consisted of five items presented on 8½" x 5½" cards from MEMORY TASKS FOR READING (WISE OWL). The cards were covered with clear acetate sheets so that after completion by each child, responses made with a washable marker could be erased with a damp sponge.

Four of the cards had five black-and-white pictures which were ordered sequentially to make a story. The pictures were ordered, in a clockwise manner, by means of heavy black arrows. The fifth card consisted of six black-and-white pictures ordered in a counterclockwise manner. The first two cards, on which all of the pictures were joined by arrows, had the word 'start' at the beginning point to direct the child. The remaining three cards did not have all the pictures connected by arrows, and had obvious beginning points.

On the back of each card, the pictures presented on the front had been rearranged into a different order, and the arrows had been removed. The child's task, after viewing and verbalizing the sequence on the front of the card, was to mark in the arrows on the back so that the sequence was the same as on the front.

Step 1: The experimenter placed the first card in front of the child, saying, "THE PICTURES ON THIS CARD TELL A STORY, ONE THAT YOU ARE FAMILIAR WITH, 'THE THREE LITTLE PIGS.' AS YOU CAN SEE, THE PICTURES ARE ORDERED BY ARROWS. I WANT YOU TO START AT THE BEGINNING OF THE STORY AND, BY FOLLOWING THE ARROWS, TELL ME WHAT IS HAPPENING. YOU START AT THE FIRST PICTURE, SAYING, 'FIRST __, SECOND __' AND SO ON, TELLING ME WHAT IS HAPPENING IN EACH PICTURE. AFTER YOU HAVE DONE THAT, I AM GOING TO TURN THE CARD OVER. ON THE BACK OF THE CARD, THE PICTURES ARE IN A DIFFERENT ORDER. YOUR JOB IS TO MARK IN THE ARROWS TO MAKE THE STORY FOLLOW IN THE SAME ORDER AS IT DOES ON THIS SIDE. AS YOU MARK IN

THE ARROWS, I WANT YOU TO RETELL THE STORY SAYING, 'FIRST __, SECOND __,' AND SO ON. DO YOU UNDERSTAND? TELL ME WHAT YOU ARE TO DO." [If the child was unable to verbalize what he/she was to do, the instructions were repeated.]

Step 2: The experimenter guided the child into verbalizing the sequence of the pictures, having the child say "first __, second __," etc.

Step 3: The card was turned over and the child was asked to mark in the arrows, verbalizing just as he/she had done on the front of the card.

Step 4: The experimenter recorded the order of the child's response, and the card was erased.

Step 5: If the child's response was incorrect, the card was turned over, and Steps 2, 3 and 4 were repeated.

Step 6: Steps 2, 3 and 4 and, where necessary, Step 5, were repeated for the four remaining cards.

Step 7: At the completion of the task, the child was asked to summarize what had been done, focussing on the usefulness of structured (i.e., using 'first, second,' etc.) verbalization in the recall of serial events.

Tasks 10-16: FILMSTRIPS

The seven filmstrips, distributed by Classroom Materials Company (310 North Second Street, Minneapolis, Minnesota 55401) were designed to be used in the development of visual perception skills, and include seven factors of visual perception.

The filmstrips were all shown on the white wall of the nurse's office at the school at a distance of seven feet. The child was seated in a comfortable chair next to the projector, and was responsible for turning the strip to the next frame once a frame had been correctly responded to. Each child saw the films individually, and responded verbally. In cases where the child encountered difficulty, he/she was asked to either step closer to the screen or to trace difficulties through with his/her fingertip on the wall-screen for that response.

Only the child's errors were recorded by the experimenter. In instances where there was an error, the child was asked to verbalize the repeated question, then to verbally work through the question and response step-by-step. Each frame received a correct response before the child went on to the next frame. The experimenter ensured, on the first few frames of each filmstrip, that the child knew what he/she was to do. In each filmstrip, the frames proceeded from easy to fairly difficult for these particular children. Questions, on those filmstrips using them, and all responses were included with the distributor's instructions.

The greatest difficulty, for those children having difficulty, lay in left-right discrimination. The only changes in the supplied questions given for each film was in supplying consistency in left-right search patterns.

Task 10: FILMSTRIP 1--VISUAL DISCRIMINATION AND SPATIAL ORIENTATION

This filmstrip consisted of 36 frames and was designed to strengthen the ability to discriminate directional differences such as right-left, and above-below in relation to objects in space. There were a total of 94 questions to be responded to by the child, each involving considerable auditory attention and auditory sequential memory.

Each frame consisted of a horizontal line, a vertical line, or a combination of both, in colors red or black. The child was asked to verbalize, by naming the color, the position of a specifically named colored dot in relation to these lines. Dots in frames 1-16 were either red or blue. Dots in frames 17-36 were red, blue, green or black.

The experimenter said to the child, "THIS FILMSTRIP IS ABOUT THE POSITION OF DOTS IN SPACE. I AM GOING TO ASK YOU QUESTIONS ABOUT THE DOTS, AND YOU WILL TELL ME THE COLOR OF THE DOT WHICH IS IN THE SPACE I AM TALKING ABOUT. IF NO DOT DOES THIS, JUST SAY 'NONE.' DO YOU UNDERSTAND? TRY THIS ONE [showing frame 1]. WHAT COLOR DOT IS ABOVE THE BLACK LINE." [If the child's response was incorrect, the instructions were repeated, then he/she was asked to repeat the question after the experimenter.] "NOW, BEFORE WE CONTINUE, I WANT TO BE SURE YOU UNDERSTAND SOME OF THE WORDS I WILL USE. SHOW ME WHERE ABOVE THE CHAIR IS? WHERE BELOW THE CHAIR IS? WHERE THE RIGHT SIDE OF YOU IS? WHERE THE

LEFT SIDE OF YOU IS?" [Where the child had difficulty, time was spent on these discriminations using clues such as 'which hand do you write with.'] "NOW, WOULD YOU LIKE TO TURN THE FILMSTRIP TO THE NEXT FRAME?"

Task 11: FILMSTRIP 2--VISUAL MATCHING

This filmstrip consisted of 36 frames and was designed to strengthen the ability to discriminate directional similarities and differences in objects, symbols and figures. There was one question for each frame, to which the child responded by saying 'yes' or 'no.'

In frames 1-14, the child was asked to compare a form on the left of the frame to a form on the right. In frames 15-36, the child was asked to compare two or more forms on the left to two or more forms on the right. Forms were divided by a vertical line.

The experimenter said [showing the first frame], "ON THE WALL ARE PICTURES OF TWO FORMS. ONE IS ON THE LEFT SIDE --POINT TO THE LEFT SIDE. THE OTHER IS ON THE RIGHT SIDE-- POINT TO THE RIGHT SIDE. NOW, YOUR JOB IS TO LOOK CAREFULLY FIRST AT THE FORM ON THE LEFT SIDE, THEN YOU ARE TO LOOK AT THE FORM ON THE RIGHT SIDE AND DECIDE IF IT LOOKS EXACTLY THE SAME AS THE ONE ON THE LEFT SIDE. IS IT FACING AND POINTING IN THE SAME DIRECTION? IF IT IS, ANSWER 'YES.' IF IT ISN'T, ANSWER 'NO.' DO YOU UNDERSTAND? WHAT IS THE ANSWER TO THIS FIRST ONE?" [If the child's response was incorrect, the instructions were repeated and the child was asked to go up and trace with his/her finger first the form on the left, then the form on the right.]

When frame 15 was introduced, the child was asked to go up and trace both forms on the left and both forms on the right. The experimenter then said, "NOW YOU MUST MAKE SURE THAT EACH FORM ON THE RIGHT IS EXACTLY THE SAME AS ITS PARTNER ON THE LEFT." Through directive questioning, the child was asked to verbalize left-right search patterns so that working from the left, on the right side, once one error was discovered, the response was 'no.'

Task 12: FILMSTRIP 3--VISUAL CONSTANCY

This filmstrip consisted of 36 frames and was designed to strengthen the ability to discriminate symbols and figures set in confusing or contrasting contexts. There was one question per frame, to which the child responded by saying 'yes' or 'no.'

In each frame, the child was asked to look at a form at the top of the frame, then decide if the form was found in a box in the lower portion of the frame. In frames 1-6, there was only one form at the top. In frames 7-22, there were two forms at the top. Here the experimenter pointed out that both frames must be present in the box, but not necessarily in the same order. In frames 27-36, there were two pairs of letters at the top, e.g., AB ST. The experimenter pointed out that each pair of letters must be found in the same order, but that the pairs need not directly follow one another. Whenever letters were used, the child was asked to verbalize the letter names (in pairs where applicable).

The experimenter said [showing the first frame], "LOOK AT THE FORM AT THE TOP OF THE SCREEN. CAN YOU SEE THE SAME FORM IN THE BOX AT THE BOTTOM OF THE SCREEN? IF YOU SEE A FORM IN THE BOX THAT LOOKS THE SAME AND IS FACING THE SAME WAY AS THE FORM AT THE TOP, SAY 'YES.' IF NOT, SAY 'NO.' DO YOU UNDERSTAND? WHAT IS THE ANSWER TO THIS FIRST ONE?" [If the child's response was incorrect, the instructions were repeated and he/she was asked to go up and trace with his/her finger first the form on top, then the corresponding form in the box.]

Task 13: FILMSTRIP 4--VISUAL-MOTOR (FORM) COORDINATION

This filmstrip consisted of 39 frames and was designed to strengthen "the ability to discriminate and construct the integral components of basic forms." There was one question per frame, to which the child responded by saying 'left,' 'right' or 'middle.'

In each frame, the child was asked to look at a form at the top left, then to compare it with the incomplete form at the top right. At the bottom of each frame were three component parts of the completed top-left form, arranged horizontally, one of which would complete correctly the top right form.

The experimenter said [showing the first frame], "PLEASE LOOK AT THIS FORM [pointing to the upper left form]. NOW, SEE THIS FORM ON THE RIGHT SIDE [pointing]? IT IS EXACTLY THE SAME, EXCEPT THAT ONE OF THE LINES HAS BEEN LEFT OUT. THE LINE THAT WAS LEFT OUT WAS ONE OF THESE ONES [pointing] ON THE BOTTOM. LOOK AT THE TWO FORMS CAREFULLY. IF YOU THINK THE MISSING LINE IS THE LEFT ONE, SAY 'LEFT.' IF YOU THINK IT IS THE MIDDLE LINE, SAY 'MIDDLE.' IF YOU THINK IT WAS THE RIGHT LINE, SAY 'RIGHT.' DO YOU UNDERSTAND? WHAT IS THE ANSWER TO THIS FIRST ONE?" [If the child's response was incorrect, the instructions were repeated and he/she was asked to go up and trace with his/her finger first the form on the upper left, then the form (and the missing line) on the upper right. Those children who had demonstrated severe left-right difficulty were allowed to respond 'first,' 'second,' and 'third,' since the task was not primarily one of left-right discrimination.]

Task 14: FILMSTRIP 5--VISUAL MEMORY

This filmstrip consisted of 36 frames and was designed to strengthen the ability to recall visual stimuli. The filmstrip was designed in pairs of frames so that the first frame of a pair presented from two to four picture cards on the bottom, and one card turned face down on the top. The second frame of the pair had either one or more of the bottom cards turned face down, and had the top card, which was a duplicate of one of the face-down cards on the bottom, turned up. The cards on the bottom were numbered, sequentially, from the left. The child's task was to recall what the position of the exposed top picture in the second frame had been in the first frame, after having seen the pictures in the first frame for two seconds.

The experimenter said [showing the first frame], "LOOK AT THE PICTURES ON THE SCREEN. THE TWO CARDS ON THE BOTTOM ARE TURNED FACE UP SO YOU CAN SEE THE PICTURES. THE CARD AT THE TOP IS TURNED FACE DOWN SO YOU CANNOT SEE THE PICTURE, BUT IT IS THE SAME AS ONE OF THE BOTTOM CARDS. LOOK AT THE TWO BOTTOM CARDS, AND SAY 'FIRST __, SECOND __,' AND SO ON, SAYING THE NAME OF THE PICTURE EACH TIME. DO YOU UNDERSTAND? NOW [turning the filmstrip to the second frame], LOOK AT THE PICTURE CARDS ON THE SCREEN. YOU CAN SEE THE TOP CARD. DO YOU REMEMBER WHICH OF THE BOTTOM CARDS IS THE SAME AS THE TOP CARD? TELL ME IF IT IS CARD 1 OR CARD 2." [If the child's response was incorrect, he/she was shown the first frame and asked to verbalize the position of the cards again.]

Task 15: FILMSTRIP 6--FIGURE-GROUND

This filmstrip consisted of 36 frames and was designed to strengthen "the ability to select the appropriate visual stimulus in spite of visual distractions." There were a total of 95 questions to be responded to by the child, each one involving considerable auditory attention and auditory sequential memory.

Each frame consisted of a triangle, a square, a circle or a combination of these, either juxtapositioned or overlapped. Red, yellow, green, blue and black dots were placed in these geometical figures. The child's task was to identify the color of dot or dots which were located within a specified geometric form or within overlapping geometric forms (e.g., What color dot or dots are in the circle but not in the triangle or the square?).

The experimenter said [showing the first frame], "IN THIS FILMSTRIP, YOU ARE GOING TO SEE SHAPES WHICH HAVE DOTS IN THEM. I AM GOING TO ASK YOU QUESTIONS ABOUT THE DOTS, AND I WANT YOU TO ANSWER BY TELLING ME WHAT THE COLOR IS OF THE DOT ASKED FOR IN THE QUESTION. YOU WILL HAVE TO LISTEN VERY CAREFULLY, AS SOME OF THE QUESTIONS BECOME QUITE COMPLICATED. TRY THIS FIRST ONE, 'WHAT COLOR DOT IS IN THE TRIANGLE?' [If the child's response was incorrect, the instructions were repeated, then the child was asked to repeat the question after the experimenter. After frame 10, where overlapping forms were introduced, the child was also asked to go up and trace the form outlines with his/her finger on the wall-screen if his response was incorrect.]

Task 16: FILMSTRIP 7--VISUALIZATION

This filmstrip consisted of 36 frames and was designed to strengthen and integrate all visual perceptual skills, focussing on left-to-right visual search patterns. There were a total of 80 questions to be responded to by the child.

Each frame consisted of one, two, or three lines which originated from letters or numbers on the left and overlapped and intertwined to end at numbers or letters, respectively, on the right. The child is asked to respond by choosing the number (letter) which completed the line started at a specifically asked letter (number).

The experimenter said [showing the first frame], "EACH FRAME IN THIS FILMSTRIP IS COMPOSED OF LINES WHICH WILL BE ALL TWISTED TOGETHER. THEY ALWAYS BEGIN AT THE LEFT [pointing] AND END AT THE RIGHT [pointing]. THIS FIRST FRAME ONLY HAS ONE LINE, AND IT BEGINS AT THE LETTER 'A.' AT WHAT NUMBER DOES IT END?" [In subsequent, more difficult frames, the child was asked to first trace the line in the air with his/her finger if he/she made an incorrect response. If this did not yield a correct response after two attempts, the child was asked to go up to the wall-screen and trace the line with his/her finger.]

CHAPTER VI

A PILOT STUDY

In order to test the materials used in intervention, a pilot study was conducted in one of the three schools for a two month period early in 1976. Eighteen children in each of Grades 2 and 4 were selected on the basis of scores on the "Reading Comprehension" subtest of the Stanford Diagnostic Reading Test (SDRT). Those children who scored below the 50th percentile were included in the pilot study. Needless to say, different children were involved in the pilot and in the main study.

Three levels of intervention were conducted in the pilot study, namely: (a) Minimum intervention, where the child viewed only the seven filmstrips; (b) Medium intervention, where the child was asked to complete various successive tasks; and (c) Maximum intervention, where the child was asked to complete various tasks, but was instructed in the use of verbal mediation and in the effective use of strategies. Children in Grades 2 and 4 were grouped into the three intervention levels, resulting in six experimental conditions. Intervention was conducted in groups of three for each condition for one-half hour daily, two days per week for eight weeks. This made a total of eight hours of group remediation per child.

Analyses of variance yielded significant differences in pre/post means between grades for all tests. This finding was expected. Analyses also revealed significant differences in pre/post means between the Minimum and the Medium and Maximum groups (grades combined) for Serial Recall ($F=27.7$, $df=2/30$, $P<.001$; $F=32.12$, $df=2/30$, $P<.001$, respectively), Free Recall [illegible]$=36.9$, $df=2/30$, $P<.001$; $F=45.82$, $df=2/30$, $P-.001$, respectively), and Memory For Designs ($F=11.9$, $df=2/30$, $P-.001$; $F=17.5$, $df=2/30$, $P<.001$, respectively). There was no significant difference in pre/post group means for Raven's Coloured Progressive Matrices or Color Naming. Digit Span-Forward was not administered. These results suggest that intervention was effective in teaching the use of successive and possibly simultaneous strategies since Serial Recall and Free Recall consistently load on the successive processing factor and Memory For Designs consistently loads on the simultaneous processing factor. The failure to find significant differences in pre/post intervention group means on the SDRT can be attributed to (i) the fact that "Reading Comprehension" may require simultaneous processing while most of the tasks included focussed primarily on successive processing, and/or to (ii) the small number of hours given for remediation.

The findings from the pilot study were of assistance in a number of ways: (a) in determining the feasibility of improving reading comprehension by means of a nonacademic training program; (b) in determining the appropriateness of the tasks in terms of their successive and simultaneous character; (c) in determining the number of children to be included in each session; (d) in determining the amount of time required for each task; and finally, (e) in determining the necessity for retaining the three different intervention levels.

Those tasks which were found to be easy for the children, and those which were felt to focus primarily on simultaneous processing were omitted from the present study. Some of the tasks were modified to include different source materials or instructions. Only those tasks which met these requirements and which fit comfortably into a 35 minute session were retained for the present study.

Although groups of three children were workable, the disruption to the total classroom was less if only one child was removed at a time.

A Minimum intervention group had been included in the pilot study in order to control for the Hawthorne Effect. Since changes for this group in the pilot study were extremely minimal, it was decided, in the interest of time and available students and personnel to omit this group in the final study. Both the Medium and Maximum intervention groups in the pilot study had shown improvement between pre- and post- test on the Primary Test Battery. However, improvement for the Maximum intervention group was clearly the best. The pilot study did not have a Control group, the Minimum intervention group serving as the control. In the final study, it was decided to maximize contrast by giving the remedial program to one group while withholding it from a comparable group; both groups, however, continued to participate in the regular class program.

CHAPTER VII

THE SUCCESSIVE-SIMULTANEOUS PROCESSING MODEL: A TEST OF HYPOTHESIS 1

HYPOTHESIS 1: Factor analysis of the Primary Test Battery will yield the factors of successive and simultaneous processing.

The question posed by this hypothesis is whether the cognitive performance in children ranging from academically "below average" to academically "average" can be explained by the successive-simultaneous processing model. Successive and simultaneous modes of information processing have been shown to be stable variables in examining individual differences within and across varying samples. The present study examines the applicability of the model to a sample of Grade 4 students with differing levels of academic performance.

Pre- and post- test means and standard deviation from the eight marker tests for the Experimental and Control groups, respectively, are presented in Table 11. In order to test Hypothesis 1, principal components analyses with varimax rotations were used, as this had been used in previous research on the Primary Test Battery. According to the Kaiser-Guttman rule, only factors with eigenvalues greater than 1.0 were accepted. The factor matrices are

Table 11

Means and Standard Deviations for the Eight Marker Tests for the Experimental Group (n=34) and the Control Group (n=34) at Both Pre- and Post- Test

EXPERIMENTAL GROUP

MARKER TESTS	PRE-		POST-	
	Mean	SD	Mean	SD
RAVEN'S MATRICES	26.11	5.14	28.73	4.57
MEMORY FOR DESIGNS	4.94	3.29	1.17	1.50
SERIAL RECALL	61.29	11.40	75.61	6.80
FREE RECALL	71.23	7.87	84.23	5.04
DIGIT SPAN-FORWARD	5.23	.77	6.00	1.05
COLOR NAMING	35.85	8.32	29.44	5.84
BENDER GESTALT	4.58	2.13	2.08	1.56
SCHONELL	43.12	9.91	54.06	11.97

CONTROL GROUP

MARKER TESTS	PRE-		POST-	
	Mean	SD	Mean	SD
RAVEN'S MATRICES	27.44	4.22	28.76	4.81
MEMORY FOR DESIGNS	4.29	3.41	3.70	2.75
SERIAL RECALL	66.20	8.39	66.79	8.07
FREE RECALL	73.38	7.12	75.59	6.77
DIGIT SPAN-FORWARD	5.41	.86	5.32	.87
COLOR NAMING	33.68	6.92	33.70	8.07
BENDER GESTALT	4.20	2.66	4.23	2.44
SCHONELL	40.50	7.11	45.61	7.48

presented in Tables 12 and 13, respectively, for pre- and post- test.

Tables 12 and 13 show that two factors were clearly obtained at both pre- and post- test, respectively. With the exception of the loading of Color Naming on the factor identified as successive processing rather than on the factor identified as speed, factor loadings conform closely to the pattern established in previous research. Factor I, identified as successive processing, has high loadings from Serial Recall (SR), Free Recall (FR), Digit Span-Forward (DS-F), and Color Naming (CN). CN measures latency, thus the negative sign. Factor II, identified as simultaneous processing has high loadings from Raven's Coloured Progressive Matrices (RCPM), and Memory For Designs (MFD). MFD is an error score, thus the negative sign on the RCPM reflects the opposite to this. These results were consistent for both pre- and post- tests. The pattern of factor loadings cannot be compared for pre- and post- test because of the possible effects of intervention on the Experimental group. However, the emergence at pre- and post- test of factor patterns and loadings similar to those of previous research suggests that the successive-simultaneous processing model can be applied to the data from the present study, and that the factors of successive and simultaneous processing, as measured by the Primary Test Battery, did in fact emerge. Hypothesis 1 is thus supported.

Table 12

Principal Components Analysis with Varimax Rotation of the Primary Test Battery at Pre-Test

(N=68)

	Factors		
VARIABLES	Successive	Simultaneous	h^2
RAVEN'S MATRICES	-.095	-.873	.770
MEMORY FOR DESIGNS	-.188	.787	.655
SERIAL RECALL	.913	-.086	.841
FREE RECALL	.895	-.082	.808
DIGIT SPAN-FORWARD	.594	.138	.372
COLOR NAMING	-.601	.160	.387
Variance	2.393	1.440	3.833

Table 13

Principal Components Analysis with Varimax Rotation of the Primary Test Battery at Post-Test (N=68)

VARIABLES	Factors		
	Successive	Simultaneous	h^2
RAVEN'S MATRICES	-.186	.877	.804
MEMORY FOR DESIGNS	-.248	-.826	.743
SERIAL RECALL	.916	.014	.840
FREE RECALL	.894	.074	.805
DIGIT SPAN-FORWARD	.759	.131	.593
COLOR NAMING	-.577	.089	.341
Variance	2.644	1.482	4.125

The scores from the Bender Visual-Motor Gestalt (BG), and the Schonell Graded Word List (SCH) were factor analyzed in conjunction with the Primary Test Battery, for both pre- and post- tests. The BG, as opposed to the MFD, does not rely on memory in the reproduction of geometric designs. Rather, the child can constantly refer to the stimulus. The SCH, while primarily an academic achievement-related test, requires a systematic search pattern for word attack. The SCH has been included in factor analysis on achievement and intelligence, where, along with other verbal and reading skills, it loaded on the factor termed "Verbal Intelligence" (Krywaniuk, 1974). When included in factor analysis on achievement and the Primary Test Battery, it loaded along with other reading and verbal skills on the factor termed "Reading" (Krywaniuk, 1974). Principal components analyses with varimax rotations for the data in the present study are reported in Tables 14 and 15 for pre- and post- test, respectively.

For pre- test, the three factors whose eigenvalues were greater than 1.0 were accepted. Factor I, identified as successive processing, has high loadings from SR, FR, and CN. CN measures latency, thus has a negative sign. Factor II, identified as simultaneous processing, has high loadings from RCPM, MFD, and BG. MFD and BG reflect error scores, thus the negative sign on RCPM reflects the opposite to this loading. Factor III, tentatively designated as

Table 14

Principal Components Analysis with Varimax Rotation of the Eight Marker Tests at Pre-Test
(N=68)

	Factors			
VARIABLES	Successive	Simultaneous	Span	h^2
RAVEN'S MATRICES	.122	-.785	-.367	.767
MEMORY FOR DESIGNS	-.180	.764	-.125	.632
SERIAL RECALL	.850	-.070	.301	.817
FREE RECALL	.867	-.048	.237	.810
DIGIT SPAN-FORWARD	.246	.008	.750	.623
COLOR NAMING	-.714	.017	-.011	.510
BENDER GESTALT	.307	.663	-.332	.644
SCHONELL	.125	-.056	.656	.449
Variance	2.201	1.651	1.400	5.251

Table 15

Principal Components Analysis with Varimax Rotation of the Eight Marker Tests at Post-Test
(N=68)

	Factors		
VARIABLES	Successive	Simultaneous	h^2
RAVEN'S MATRICES	-.221	.846	.764
MEMORY FOR DESIGNS	-.218	-.809	.701
SERIAL RECALL	.894	.015	.800
FREE RECALL	.869	.063	.759
DIGIT SPAN-FORWARD	.735	.113	.553
COLOR NAMING	-.590	.072	.353
BENDER GESTALT	-.439	-.435	.381
SCHONELL	.534	.260	.353
Variance	3.017	1.648	4.664

reading, has high loadings from DS-F and SCH, and a slight negative loading from RCPM. It may be useful to consider that this is a span factor. None of the 68 subjects experienced difficulty with DS-F or SCH until the item presented was composed of more than four units (digits or letters, respectively). RCPM has six alternatives from which to choose. The negative RCPM loading may reflect a failure to look at all six alternatives, which interfered with successful completion of the task. SR and FR, which have only four units for each item, did not pose a span difficulty, and thus did not load on this factor. The factor patterns obtained from the present factor analyses were similar to those obtained by Krywaniuk (1974). Factor analysis on achievement and cognitive tests for both high and low achievers in the third grade indicated that Figure Copying loaded on the simultaneous factor (Krywaniuk, 1974). As was pointed out in Chapter IV, Figure Copying and BG are very similar tests. The loading of BG on the simultaneous factor in the present analyses is consistent with previous research using the Figure Copying Test (refer to Table 9, in Chapter IV). In the same analysis as just previously mentioned, Krywaniuk (1974) also found that SCH loaded on a factor which he labelled "Reading." However, inspection of the other tests which loaded on this factor reveals that these tests also require attention and responses to longer combinations of units of material (i.e., Gates-MacGinitie Vocabulary and Comprehension subtests, Spelling, and Stanford Achievement "Paragraph Meaning" subtest). Thus, the SCH loading in the present analysis is consistent with previous findings.

At post- test, there emerged only two factors with eigenvalues greater than 1.0. Factor I, identified as successive processing has high loadings from SR, FR, DS-F, CN, and SCH. CN measures latency, thus it has a negative sign. Factor II, identified as simultaneous processing, has high loadings from RCPM and MFD. BG loaded about equally on Factors I and II. MFD and BG are error scores, thus have negative signs. A third factor did not emerge. It seems that successive processing strategies had become sufficient for solving DS-F and SCH. A comparison between pre- and post- test factor patterns and loadings is not possible because of the confounding effect of including the Control group, which did not receive intervention, in post-test analysis. However, possible reasons for the relationships between the two additional tests and the Primary Test Battery at post- test, as compared to pre- test, will be more illustratively explained in the next chapter.

Summary

The similarity of the results of the analyses in the present study to those reported in previous research suggests that the successive-simultaneous processing model can be applied to the data of the present study. Hypothesis 1 can therefore be accepted.

Pre- and post- test factor patterns could not be compared, since data from all 68 subjects was used. Thus, post- test results were confounded by inclusion of the Control group, which had received no intervention. However, possible reasons for the change in factor structure and loadings will be discussed in the next chapter.

Results from these analyses must be regarded with some caution. Principal components analysis should ideally have a sample size of at least 100 (Gorsuch, 1974). However, results are suggestive and tend to confirm findings from previous research.

CHAPTER VIII

THE APPLICABILITY OF INTERVENTION: A TEST OF HYPOTHESES 2(a) AND 2(b)

A. HYPOTHESIS 2(a): Improvement in performance on the successive and simultaneous marker tests following intervention will be greater for the Experimental group than for the Control group.

This hypothesis poses the question of whether remedial intervention which stresses the use of successive strategies will improve cognitive performance, as measured by the marker tests. In previous chapters, it has been shown that successive processing skills are important to academic achievement. Consequently, an intervention program (described in Chapter V) which emphasized the use of successive strategies was designed and implemented with children who were both academically "average" and academically "below average."

Pre- and post- test means and stardard deviations, based on all 68 subjects, for the eight marker tests were presented in Table 11. Table 16 presents, for the four groups used in the present study (n=17), the means and standard deviations for the eight marker tests, at both

Table 16

Means and Standard Deviations for the Eight Marker Tests, at Both Pre- and Post- Test, for Each of the Four Groups Used in the Present Study

MARKER TESTS	EXPERIMENTAL "AVERAGE" Pre-		Post-		CONTROL "AVERAGE" Pre-		Post-	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
RAVEN'S MATRICES	25.88	5.38	29.29	4.22	27.71	4.19	29.18	3.75
MEMORY FOR DESIGNS	4.47	3.08	.88	1.11	4.35	3.37	3.23	3.27
SERIAL RECALL	64.18	7.99	75.23	5.75	68.23	7.70	68.35	7.36
FREE RECALL	73.65	5.64	83.88	4.40	75.12	6.30	76.53	6.53
DIGIT SPAN-FORWARD	5.35	.61	5.88	.93	5.47	.87	5.76	.97
COLOR NAMING	33.94	6.54	28.35	5.15	30.71	5.53	32.18	6.63
BENDER GESTALT	4.41	1.87	1.94	1.34	3.82	1.98	3.65	2.21
SCHONELL	49.65	9.84	60.18	11.18	45.82	6.65	50.41	8.02

MARKER TESTS	EXP. "BELOW AVERAGE" Pre-		Post-		CONT. "BELOW AVERAGE" Pre-		Post-	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
RAVEN'S MATRICES	26.35	4.90	28.18	4.93	27.18	4.25	28.35	5.88
MEMORY FOR DESIGNS	5.41	3.50	1.47	1.90	4.23	3.46	4.18	2.24
SERIAL RECALL	58.41	14.82	76.00	7.86	64.18	9.08	65.23	8.79
FREE RECALL	68.82	10.11	84.59	5.68	71.65	7.95	74.65	7.02
DIGIT SPAN-FORWARD	5.12	.93	6.12	1.17	5.35	.86	4.88	.78
COLOR NAMING	37.76	10.10	30.53	6.53	36.65	8.31	35.23	9.52
BENDER GESTALT	4.76	2.39	2.23	1.78	4.59	3.34	4.82	2.67
SCHONELL	36.59	9.99	47.94	12.76	35.18	7.57	40.82	6.94

pre- and post- test. In order that the data be more illustrative, the means for each of the marker tests were converted into standardized group means for pre- and post-test using the appropriate data, respectively:

$$\frac{\overline{X}_{group(n=17)} - \overline{X}_{total(N=68)}}{SD_{total(N=68)}} \text{ (Ferguson, 1971).}$$

These standardized group means are presented in Table 17.

Discussion of Pre- to Post- Improvement: Analyses of Variance

Analyses of variance were calculated separately, for each of the marker tests, using a three factor design with repeated measures on the last factor (Winer, 1962). The factors were: Experimental/Control; "Average"/"Below Average"; and Pre-/Post- Test Scores. A summary of these analyses is presented in Table 18. On all tests, the average performance of all subjects improved significantly between pre- and post- tests. This improvement could be interpreted to be the result of maturation and/or practice effect. However, on all tests, with the exception of RCPM, there was a significant Exp/Cont X Pre/Post interaction. This would indicate that while some pre/post improvement may have been attributable to maturation and/or practice effect, a major portion of the improvement was attributed to experimental intervention. These interactions will be discussed separately under each marker test.

Table 17

Standardized Group Means for Each of the Marker Tests

MARKER TESTS	EXPERIMENTAL "AVERAGE"		CONTROL "AVERAGE"		EXPERIMENTAL "BELOW AVERAGE"		CONTROL "BELOW AVERAGE"	
	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-
RAVEN'S MATRICES	-.19	.12	.20	.09	-.09	-.12	.09	-.09
MEMORY FOR DESIGNS	-.05	-.61	-.08	.31	.24	-.38	-.12	.68
SERIAL RECALL	.04	.47	.42	-.33	-.50	.56	.04	-.69
FREE RECALL	.17	.54	.36	-.46	-.45	.64	-.08	-.72
DIGIT SPAN-FORWARD	.04	.21	.18	.09	-.25	.44	.04	-.74
COLOR NAMING	-.02	-.44	-.50	.08	.37	-.14	.23	.50
BENDER GESTALT	.00	-.53	-.24	.21	.15	-.40	.08	.72
SCHONELL	.76	.87	.39	.05	-.50	-.16	-.64	-.76

Table 18

Summary of Analyses for Marker Tests
Three-Way Analyses of Variance with One Factor Repeated

MARKER TESTS	SOURCE (Expressed as Calculated F-Ratio)						
	A(EXP/CONT)	B("AV"/"BELOW AV")	AB	C(PRE/POST)	AC	BC	ABC
RAVEN'S MATRICES	-	-	-	23.04^c	-	-	-
MEMORY FOR DESIGNS	-	-	-	48.42^c	25.78^c	-	-
SERIAL RECALL	-	-	-	59.56^c	50.54^c	-	-
FREE RECALL	4.92^a	-	-	89.02^c	44.86^c	4.87^a	-
DIGIT SPAN-FORWARD	-	-	-	7.55^b	11.99^c	-	6.29^a
COLOR NAMING	-	5.20^a	-	17.17^c	17.48^c	-	-
BENDER GESTALT	4.13	-	-	13.28^c	13.92^c	-	-
SCHONELL	6.70^a	28.40^c	-	112.22^c	14.76^c	-	-

a: $P<.05$
b: $P<.01$
c: $P<.001$

1. Raven's Coloured Progressive Matrices (RCPM)

The summary of the analysis for the RCPM is presented in Table 19. The analysis indicates that the average performance of both groups on the RCPM improved between pre- and post- test. When the results were analyzed separately for each group (t-tests), there was no significant improvement for any one group. Thus, in the present analysis, the pre/post improvement acquired significance from the combined improvement of all groups, and could, in fact be due to maturation and/or practice effects, and not due to intervention.

2. Memory For Designs (MFD)

The summary of the analysis for the MFD is presented in Table 20. Both the Pre/Post main effect and the Exp/Cont X Pre/Post interaction are significant. While both groups showed improvement between pre- and post- test, improvement for the Experimental group was significantly greater than improvement for the Control group.

3. Serial Recall (SR)

The summary of the analysis for SR is presented in Table 21. Both the Pre/Post main effect and the Exp/Cont X Pre/Post interaction are significant. While both groups showed improvement between pre- and post- test, improvement for the Experimental group was significantly greater than improvement for the Control group.

Table 19

Three-Way Analysis of Variance with One Factor Repeated for Raven's Coloured Progressive Matrices (RCPM)

SOURCE	SS	DF	MS	F	P
Bet Subj	2528.50	67			
A(Exp/Cont)	15.56	1	15.56	.40	-
B("Av"/"BAv")	8.50	1	8.50	.22	-
AB	1.06	1	1.06	.03	-
Subj w grp	2503.37	64	39.11		
Within Subj	524.00	68			
C(Pre/Post)	132.00	1	132.00	23.04	.001
AC	14.25	1	14.25	2.49	-
BC	7.56	1	7.56	1.32	-
ABC	3.56	1	3.56	.62	-
C X Subj w grp	366.62	64	5.73		

Table 20

Three-Way Analysis of Variance with One Factor Repeated for Memory For Designs (MFD)

SOURCE	SS	DF	MS	F	P
Bet Subj	880.00	67			
A(Exp/Cont)	30.12	1	30.12	2.30	-
B("Av"/"BAv")	11.76	1	11.76	.90	-
AB	1.06	1	1.06	.08	-
Subj w grp	837.94	64	13.09		
Within Subj	465.00	68			
C(Pre/Post)	161.06	1	161.06	48.42	.001
AC	85.76	1	85.76	25.78	.001
BC	1.06	1	1.06	.32	-
ABC	4.23	1	4.23	1.27	-
C X Subj w grp	212.88	64	3.33		

Table 21

Three-Way Analysis of Variance with One Factor Repeated for Serial Recall (SR)

SOURCE	SS	DF	MS	F	P
Bet Subj	8850.50	67			
A(Exp/Cont)	130.00	1	130.00	.99	-
B("Av"/"BAv")	315.00	1	315.00	2.40	-
AB	10.19	1	10.19	.08	-
Subj w grp	8395.31	64	131.18		
Within Subj	5709.50	68			
C(Pre/Post)	1890.00	1	1890.00	59.56	.001
AC	1603.69	1	1603.69	50.54	.001
BC	118.44	1	118.44	3.73	-
ABC	67.00	1	67.00	2.11	-
C X Subj w grp	2030.81	64	31.73		

4. Free Recall (FR)

The summary of the analysis for FR is presented in Table 22. On this test, both the Exp/Cont and the Pre/Post main effects, as well as both the Exp/Cont X Pre/Post interaction and the "Av"/"BAv" X Pre/Post interaction are all significant. The overall performance of the Experimental group was significantly higher than that of the Control group. When the results were analyzed separately, the pre-test difference in scores between groups was not significant (t=-1.12, df=66, P>.05). Thus, significant difference in overall performance is mainly due to combination of all pre/post differences in performance. While both groups showed improvement between pre- and post- test, improvement for the Experimental group was significantly greater than improvement for the Control group. While both the "Average" and "Below Average" groups showed improvement between pre- and post- test, improvement for the "Below Average" group was significantly greater than improvement for the "Average" group.

5. Digit Span-Forward (DS-F)

The summary of the analysis for DS-F is presented in Table 23. The Pre/Post main effect, the Exp/Cont X Pre/Post interaction, and the Exp/Cont X "Av"/"BAv" X Pre/Post interaction are all significant. While there was an overall improvement between pre- and post- test, the

Table 22

Three-Way Analysis of Variance with One Factor Repeated for Free Recall (FR)

SOURCE	SS	DF	MS.	F	P
Bet Subj	5227.87	67			
A(Exp/Cont)	359.06	1	359.06	4.92	.05
B("Av"/"BAv")	190.56	1	190.56	2.61	-
AB	3.06	1	3.06	.04	-
Subj w grp	4675.19	64	73.05		
Within Subj	4509.50	68			
C(Pre/Post)	1965.19	1	1965.19	89.02	.001
AC	990.31	1	990.31	44.86	.001
BC	107.56	1	107.56	4.87	.05
ABC	34.06	1	34.06	1.54	-
C X Subj w grp	1412.81	64	22.07		

Table 23

Three-Way Analysis of Variance with One Factor Repeated for Digit Span-Forward (DS-F)

SOURCE	SS	DF	MS	F	P
Bet Subj	77.50	67			
A(Exp/Cont)	2.12	1	2.12	1.91	-
B("Av"/"BAv")	2.12	1	2.12	1.91	-
AB	2.12	1	2.12	1.91	-
Subj w grp	71.12	64	1.11		
Within Subj	46.50	68			
C(Pre/Post)	3.89	1	3.89	7.55	.01
AC	6.18	1	6.18	11.99	.001
BC	.18	1	.18	.36	-
ABC	3.24	1	3.24	6.29	.05
C X Subj w grp	33.00	64	.52		

Experimental group improved significantly. The effect of intervention on the degree (and direction) of change is dependent upon the "Av"/"BAv" subgrouping within the Exp/Cont grouping. Thus, while the Experimental "Below Average" group showed greater improvement than the Experimental "Average" group, the difference was not significant (t=-1.14, df=32, P>.05). The Control "Average" group showed improvement, while the Control "Below Average" group showed decrease. This difference in change was significant (t=2.84, df=32, P<.01). Concomitantly, the difference in change between the Experimental "Below Average" group and the Control "Below Average" group was also significant (t=4.03, df=32, P<.001), while the difference in change between the Experimental "Average" group and the Control "Average" group was not significant (t=.71, df=32, P>.05). Thus, the ABC interaction F-ratio acquired significance from the pronounced decrease in pre/post performance of the Control "Below Average" group, which is difficult to explain. A possible, admittedly post hoc explanation, is that the "Below Average" students had all found this task difficult at pre- test. However, they were motivated to perform well since they did not know the purpose of the tests. At post- test, the Control "Below Average" group had not had the benefit of intervention, and knew that results of the test would have no bearing on their future. Thus, they may not have been motivated to try beyond their level of competence.

6. Color Naming (CN)

The summary of the analysis for CN is presented in Table 24. The "Av"/"BAv" main effect, the Pre/Post main effect, and the Exp/Cont X Pre/Post interaction are all significant. The overall performance of the "Average" group is significantly better than that of the "Below Average" group. When the results were analyzed separately, the pre-test difference in scores was significant (t=2.59, df=66, P<.01), while post-test differences were not significant (t=-1.47, df=66, P>.05). Differences in scores were always in favor of the "Average" group, but the significance of the overall difference is due mainly to the initially lower scores and subsequent degree of change in the "Below Average" group. While there was an overall improvement in scores (i.e., decrease in time) between pre- and post- test, the Experimental group improved significantly while the Control group showed a very slight (nonsignificant) decline.

7. Bender Visual-Motor Gestalt (BG)

The summary of the analysis for BG is presented in Table 25. The Exp/Cont main effect, the Pre/Post main effect, and the Exp/Cont X Pre/Post interaction are al significant. The overall performance of the Experimental group is significantly better than that of the Control group. When the results were analyzed separately, the

Table 24

Three-Way Analysis of Variance with One Factor Repeated for Color Naming (CN)

SOURCE	SS	DF	MS	F	P
Bet Subj	6414.62	67			
A(Exp/Cont)	37.06	1	37.06	.40	-
B("Av"/"BAv")	478.12	1	478.12	5.20	.05
AB	19.12	1	19.12	.21	-
Subj w grp	5880.31	64	91.88		
Within Subj	2036.50	68			
C(Pre/Post)	346.25	1	346.25	17.17	.001
AC	352.62	1	352.62	17.48	.001
BC	43.56	1	43.56	2.16	-
ABC	3.31	1	3.31	.16	-
C X Subj w grp	1290.75	64	20.17		

Table 25

Three-Way Analysis of Variance with One Factor Repeated
for Bender Visual-Motor Gestalt (BG)

SOURCE	SS	DF	MS	F	P
Bet Sub	454.38	67			
A(Exp/Cont)	26.47	1	26.47	4.13	.05
B("Av"/"BAv")	14.23	1	14.23	2.22	-
AB	3.56	1	3.56	.56	-
Subj w grp	410.12	64	6.41		
Within Subj	357.00	68			
C(Pre/Post)	51.88	1	51.88	13.28	.001
AC	54.38	1	54.38	13.92	.001
BC	.26	1	.26	.07	-
ABC	.47	1	.47	.12	-
C X Subj w grp	250.00	64	3.91		

pre- test difference in scores was not significant (t=.64, df=66, P>.05). Thus, a difference in overall performance is mainly due to post- test improvement in the performance of the Experimental group.

8. Schonell Graded Word List (SCH)

The summary of the analysis for SCH is presented in Table 26. The Exp/Cont main effect, the "Av"/"BAv" main effect, the Pre/Post main effect, and the Exp/Cont X Pre/Post interaction are all significant. The overall performance of the Experimental group was significantly better than that of the Control group. When the results were analyzed separately, the pre- test difference in scores was not significant (t=1.03, df=66, P>.05) as was anticipated. Thus, significant difference in overall performance is mainly due to post- test differences in performance.

The overall performance of the "Average" group was significantly greater than that of the "Below Average" group. When the results were analyzed separately, the pre- test differences were significantly different (t=5.67, df=66, P<.001), as were the post- test differences (t=4.18, df=66, P<.001). These results had been expected, on the basis of the academic difference between the "Average" and "Below Average" groups.

Table 26

Three-Way Analysis of Variance with One Factor Repeated for Schonell Graded Word List (SCH)

SOURCE	SS	DF	MS	F	P
Bet Subj	15425.81	67			
A(Exp/Cont)	1039.56	1	1039.56	6.70	.05
B("Av"/"BAv")	4404.94	1	4404.94	28.40	.001
AB	54.37	1	54.37	.35	-
Subj w grp	9926.94	64	155.11		
Within Subj	3738.00	68			
C(Pre/Post)	2192.00	1	2192.00	112.22	.001
AC	288.25	1	288.25	14.76	.001
BG	7.62	1	7.62	.39	-
ABC	.06	1	.06	.00	-
C X Subj w g	1250.06	64	19.53		

While both groups showed improvement between pre- and post- test, improvement for the Experimental group was significantly greater than improvement for the Control group.

Summary: A Test of Hypothesis 2(a)

In order to test Hypothesis 2(a), a three-way analysis of variance with repeated measures on one factor was calculated for each of the eight marker tests. These analyses indicated that while overall performance on the test items improved between pre- and post- test, improvement for the Experimental group was significantly greater than improvement for the Control group on all marker tests except RCPM. Hypothesis 2(a) can therefore be accepted for these marker tests.

Intervention, in the present study, emphasized the successive strategy, with concomitant secondary emphasis on the simultaneous strategy where this was amenable to the particular task. An important facet of the intervention was the child's verbalization and his active participation on the tasks. Both RCPM and MFD are primarily simultaneous tasks. However, MFD lends itself better to the procedures, and to the type of interaction with the tasks used in intervention, i.e., the child must verbalize and actively participate in both completion of the task and in acquiring the strategy being presented. The intervention procedures included labelling, consistent search and recall, and verbalization of each action. Jensen (1966) pointed out that RCPM is a task which does not immediately appear to be verbal, and may not tend to arouse verbalization in children who are nonmediators. The format of RCPM does not allow for active manipulation of the material, thus may not have initiated verbal search and recall. However, training in verbalization, and the use of the successive strategy, did significantly improve scores on tests measuring successive processing, while concurrent consistent use of procedures, e.g., search and recall patterns, improved scores on tests such as MFD. Similarly, training in successive skills would appear to have transferred to word attack skills, as was measured by the achievement-related SCH. This interpretation seems feasible, since phonetic word attack, which is taught in these schools, requires a consistent left-right search pattern followed by successive phonetic recall in blending. This finding has important implications for future research, as well as for classroom applicability. A test, which has been used primarily as a measure of word attack level, has been shown to be a fairly sensitive measure of strategy usage. Further, the strategy used is susceptible to strengthening, or to change where it had been inappropriate. Thus, it would appear that word attack skills can be strengthened by training the use of predominantly successive strategies.

B. HYPOTHESIS 2(b): Within the Experimental group, improvement in performance on the successive and simultaneous marker tests after intervention will be greater for the "Below Average" group than for the "Average" group.

As was discussed in previous chapters, it has been consistently demonstrated that children with learning problems and low academic achievement have poorly developed sequential skills. Krywaniuk (1974) and Cummins and Das (1977) have shown that success in reading is strongly related to successive processing. This being the case, intervention which predominantly stresses the use of successive strategies should be more beneficial to those children who are "Below Average" academically than to those who are academically "Average." The latter group of children should have more highly developed, and/or make more efficient use of, successive strategies, and thus may not benefit as much from extensive training in the use of these strategies.

The analyses in this section were based on the data from the 34 subjects in the Experimental group. Means and standard deviations for the eight marker tests, at both pre- and post- test, were presented in Table 16. In order to test Hypothesis 2(b), a t-test for two independent means was calculated for each marker test, using the difference between pre- and post- test means for each group (Winer, 1962). A summary of these analyses is presented in Table 27. Significant differences in pre/post means between the "Average" Experimental group and the "Below Average" Experimental group were revealed for SR and FR. In both cases, improvement for the "Below Average" group was significantly greater than improvement for the "Average" group. The fact that significant differences in improvement were not revealed for the other six marker tests means that Hypothesis 2(b) cannot be accepted. However, inspection of the means of the six remaining marker tests reveals that, while both groups improved between pre- and post- test, on five of the six tests improvement for the "Below Average" group was greater, although not significantly so, than improvement for the "Average" group. One important fact to keep in mind is that in the present study, the "Below Average" groups were essentially a lower extension of the "Average" groups. The trend noted in the results of the present study has definite implications for future research using children whose achievement is truly below average for their mental and chronological age.

Table 27

Summary of t-Tests for Difference Between Pre- and Post- Test Means of the Experimental "Average" and Experimental "Below Average" Groups

MARKER	EXPERIMENTAL "AVERAGE		EXPERIMENTAL "BELOW AVERAGE"	
TESTS	Mean	SD	Mean	SD
RAVEN'S MATRICES	3.41	3.41	1.82	3.32
MEMORY FOR DESIGNS	3.59	2.94	3.94	2.90
SERIAL RECALL	11.06*	5.76	17.59*	11.87
FREE RECALL	10.23*	4.62	15.76*	7.66
DIGIT SPAN-FORWARD	.53	1.23	1.00	1.17
COLOR NAMING	5.59	8.19	8.18	6.25
BENDER GESTALT	2.47	2.69	2.53	3.02
SCHONELL	10.53	7.85	11.35	8.18

*, $P<.05$

CHAPTER IX

THE DEVELOPMENT OF EFFICIENT STRATEGY USE: A TEST OF HYPOTHESES 3(a) AND 3(b)

HYPOTHESIS 3(a): After intervention, the number of children effectively using successive processing strategies will be greater for the Experimental group than for the Control group.

This hypothesis queries whether intervention which stresses the use of information processing strategies will improve individualized efficiency in information processing. In the previous chapter, it was shown that intervention was effective in improving cognitive performance. It is assumed that improved cognitive performance is the result of more efficient use of information processing strategies.

The analyses in this section were based on the data from all 68 subjects used in the study. Tables 12 and 13 have shown that at pre- and post- test, respectively, two factors were clearly obtained from the Primary Test Battery, namely, successive processing, and simultaneous processing. However, for the present analyses, only those four tests which have been shown by previous research to load consistently on one factor or the other were chosen. SR and DS-F have been shown to load consistently on the successive processing factor, while RCPM and MFD have been shown to load consistently on the simultaneous processing factor. In order to ensure a true numerical representation of high and low factor scores, for the following analyses the error score of the MFD was changed to a score representing the number correct out of a possible 45. The factor matrices, using only the four tests mentioned above, are presented for pre- and post- test in Tables 28 and 29, respectively.

In order to test Hypothesis 3(a), factor scores for each child were calculated at both pre- and post- test. Factor scores are based on the matrix computed from the respective principal components analysis with varimax rotation. Thus, each child was designated a specific score on each of the factors, successive and simultaneous, at both pre- and post- test. In this way, overall factor structure is represented as individual scores for each child.

By deriving the median factor score for each of the factors, it was possible to designate children into one of four categories: High Successive-High Simultaneous (HSu-HSi); High Successive-Low Simultaneous (HSu-LSi); Low Successive-High Simultaneous (LSu-HSi); and

Table 28

Principal Components Analysis with Varimax Rotation of Four Tests of the Primary Test Battery at Pre-Test (N=68)

	Factors		
VARIABLES	Successive	Simultaneous	h^2
RAVEN'S MATRICES	-.046	.853	.730
MEMORY FOR DESIGNS	.151	.826	.705
SERIAL RECALL	.966	.064	.937
DIGIT SPAN-FORWARD	.959	.049	.922
Variance	1.878	1.416	3.293

Table 29

Principal Components Analysis with Varimax Rotation of Four Tests of the Primary Test Battery at Post-Test (N=68)

	Factors		
VARIABLES	Successive	Simultaneous	h^2
RAVEN'S MATRICES	-.192	.872	.798
MEMORY FOR DESIGNS	.270	.837	.773
SERIAL RECALL	.963	-.001	.927
DIGIT SPAN-FORWARD	.959	.055	.922
Variance	1.956	1.464	3.420

Low Successive-Low Simultaneous (LSu-LSi). Table 30 presents the number of Experimental group children within each of the four categories at both pre- and post- test. Table 31 presents the number of Control group children within each of the four categories at both pre- and post-test. A significant difference between proportions at pre- and post- test was revealed for both Experimental and Control children designated as LSu-LSi. While the proportion of LSu-LSi decreased significantly within the Experimental group, the proportion increased significantly within the Control group ($z=-3.25$, $P<.001$; $z=2.30$, $P<.05$, respectively).

By combining the HSu-HSi and HSu-LSi groups, it was possible to compare HSu children at pre- and post- test. Within the Experimental group, there was a significant increase in the proportion of children designated as HSu ($z=-4.22$, $P<.001$), while within the Control group there was a significant decrease in the proportion of children designated as HSu ($z=3.16$, $P<.001$). When HSi children were compared, by combining HSu-HSi and LSu-HSi, there was no significant difference between proportions at pre- and post- test for either the Experimental group or the Control group ($z=-1.16$, $P>.05$; $z=1.27$, $P>.05$, respectively).

These results indicate that the proportion of children in the Experimental group categorized as LSu-LSi decreased significantly. While there was a significant increase in

Table 30

The Number of Experimental Group Children Within Each of the Four Categories at Both Pre- and Post- Test (n=34)

	HSu-HSi	HSu-LSi	LSu-HSi	LSu-LSi
PRE-TEST	10	5	3	16
POST-TEST	15	13	3	3

Table 31

The Number of Control Group Children within Each of the Four Categories at Both Pre- and Post- Test (n=34)

	HSu-HSi	HSu-LSi	LSu-HSi	LSu-LSi
PRE-TEST	11	8	10	5
POST-TEST	3	3	13	15

the proportion of Experimental group children designated as HSu, the increase for children designated as HSi was not significant. These findings support the supposition that effective use of successive processing strategies can be taught.

It was thought that examining individual pre/post changes in factor scores would provide further supportive evidence that efficient strategy usage can be taught. The categorizations into HSu-HSi, HSu-LSi, LSu-HSi, and LSu-LSi were again examined, this time comparing separately each individual's pre- and post- test factor scores. In this manner, it was possible to determine if each child had improved, remained the same, or decreased in the efficient use of either the successive or the simultaneous processing strategies. Table 32 presents the pre/post changes in successive processing within both the Experimental and Control groups. The proportion of children who decreased in the efficient use of successive processing was significantly greater for the Control group than for the Experimental group ($z=-3.15$, $P<.001$). Conversely, and logically, the proportion of children who increased in the efficient use of successive processing was significantly greater for the Experimental group than for the Control group ($z=2.77$, $P<.01$). The Experimental/Control difference in the proportion of children who showed no change in use of

Table 32

Pre/Post Changes in Successive Processing within both the Experimental and Control Groups

	EXPERIMENTAL	CONTROL
Decreased	0	14
Improved	13	1
No Change	21	19

successive processing was not significant (z=.60, P>.05). Table 33 presents pre/post changes in simultaneous processing within both the Experimental and Control groups. While the Experimental group did show more improvement than did the Control group in efficient use of simultaneous processing, this difference was not significant (z=1.28, P>.05). The Experimental/Control difference in the proportion of children who showed no change in use of simultaneous processing was not significant (z=.37, P>.05). Hypothesis 3(a) can therefore be accepted.

HYPOTHESIS 3(b): After intervention, the number of children in the Experimental group effectively using successive processing strategies will be greater for the "Below Average" group than for the "Average" group.

The factor matrices using only the two tests shown by previous research to load consistently on the successive factor (SR and DS-F), and the two tests shown by previous research to load consistently on the simultaneous factor (RCPM and MFD) were presented for pre- and post- test in Tables 28 and 29, respectively. The factor scores for each child at pre- and post- test were presented in Appendix J. Table 34 presents the number of children from the Experimental "Average" and Experimental "Below Average"

Table 33

Pre/Post Changes in Simultaneous Processing within both the Experimental and Control Groups

	EXPERIMENTAL	CONTROL
Decreased	2	6
Improved	7	1
No Change	25	27

Table 34

The Number of Children from the Experimental "Average" and Experimental "Below Average" Groups within Each of the Four Categories at Both Pre- and Post- Test

(n=34)

		HSu-HSi	HSu-LSi	LSu-HSi	LSu-LSi
"AVERAGE"	PRE-TEST	6	3	1	7
	POST-TEST	9	4	3	1
"BELOW AVERAGE"	PRE-TEST	4	2	2	9
	POST-TEST	6	9	0	2

groups within each of the four categories (HSu-HSi, HSu-LSi, LSu-HSi, LSu-LSi) at both pre- and post- test. By combining the HSu-HSi and HSu-LSi categories, it is possible to compare HSu children at pre- and post- test. While the proportion of children in the Experimental "Below Average" group designated as HSu increased significantly between pre- and post- test ($z=2.07$, $P<.05$), the increase in the proportion of HSu children in the Experimental "Average" group was not significant ($z=-.92$, $P>.05$).

These results indicate that the change in factor scores was significantly greater for the Experimental "Below Average" group than for the Experimental "Average" group; thus, Hypothesis 3(b) can be accepted. These results lend support to the hypothesis that children who are not achieving up to academic potential may not be using efficient organizational strategies (e.g., Freston and Drew, 1974; Parker et al., 1975; Torgeson, 1977). In other words, training in the use of successive strategies not only increased performance in children achieving below their academic level, but it also apparently increased their efficient use of successive strategies in processing information for output.

These findings have important implications for future research within the Das et al. (1975) information processing model. Not only was performance or output shown to improve after intervention stressing the use of successive strategies, but the actual use of successive strategies in central processing, in those tasks demanding the use of this strategy, can also be assumed to have increased.

CHAPTER X

FACTOR STRUCTURE OF THE METROPOLITAN ACHIEVEMENT TEST

The Metropolitan [illegible]ent Test (MAT) is composed of seven subtests and t[illegible]parate derived composite scores for reading and mathematics. Subtests include "Word Knowledge," "Reading," "Language," "Spelling," "Mathematics Computation," "Mathematics Concepts," and "Mathematics Problem Solving." The "Reading Composite" score is based on a summation of scores on "Word Knowledge" and "Reading." The "Mathematics Composite" score is based on a summation of scores on "Mathematics Computation," "Mathematics Concepts," and "Mathematics Problem Solving." Each MAT battery is designed for a specific grade. The battery used in the present study, the Elementary Battery, is specifically for Grades 3 and 4. Different forms of the Elementary Battery were administered at pre- test (Form G) and post- test (Form F) in order to avoid practice effect.

The MAT has been used previously, as in the present study, as a method of differentiating poor from normal readers (e.g., Allington, Gormley, and Truex, 1976). In a study investigating the relationship between visual sequential memory and reading, Guthrie and Goldberg (1972) found that in a group of disabled readers the MAT "Reading" subtest correlated significantly with the Benton Visual Retention Test. In order to study the interrelationships among the MAT subtests, factor analyses were performed. MAT scores were intercorrelated and the resultant matrices were submitted to a principal components analysis with varimax rotation. Following the Kaiser-Guttman rule, only factors with eigenvalues greater than 1.0 were accepted.

A series of analyses were computed in order to explore the relationships among:

(i) The seven subtests of the MAT, i.e., "Word Knowledge," "Reading," "Language," "Spelling," "Mathematics Computation," "Mathematics Concepts," and "Mathematics Problem Solving;" and

(ii) The seven MAT subtests and the marker tests.

Results of Factor Analyses Exploring the Relationship Among the Seven Subtests of the MAT

Pre- test means and standard deviations for all nine subtests are presented in Table 35. Analyses included scores from only the seven administered subtests since, as was previously explained, the "Reading Composite" and "Mathematics Composite" scores are summations of related subtest scores. Two factors emerged at pre- test (refer to Table 36). These factors could be named "Reading" and "Mathematics," since initial scrutiny reveals high loadings

Table 35

Means and Standard Deviations for the Metropolitan Achievement Test Subtest (Raw Scores) Scores for Both Pre- and Post- Tests
(N=68)

	Pre-Test		Post-Test	
SUBTESTS	Mean	SD	Mean	SD
WORD KNOWLEDGE	35.32	9.00	38.97	7.11
READING	25.37	6.66	28.99	6.18
READING COMPOSITE	60.68	10.71	70.45	9.86
LANGUAGE	26.12	7.90	30.21	8.59
SPELLING	26.50	9.07	32.51	6.86
MATH. COMPUT.	19.94	5.47	28.13	6.21
MATH. CONCEPTS	20.91	5.93	25.32	5.59
MATH. PROB. SOLV.	18.71	5.60	21.75	5.98
MATH. COMPOSITE	59.58	9.21	75.20	11.59

Table 36

Principal Components Analysis with Varimax Rotation of the Metropolitan Achievement Test Subtest (Raw Scores) Scores (Excluding Reading and Mathematics Composite Scores) at Pre-Test
(N=68)

	FACTORS		
SUBTESTS	Reading	Mathematics	h^2
WORD KNOWLEDGE	.913	.049	.836
READING	.883	.153	.803
LANGUAGE	.769	.223	.641
SPELLING	.746	.282	.636
MATH. COMPUT.	-.030	.903	.817
MATH. CONCEPTS	.518	.678	.729
MATH. PROB. SOLV.	.304	.818	.762
Variance	3.124	2.100	5.224

from reading subtests on one, and high loadings from the mathematics subtests on the other. Obviously, there is some overlap in loadings. "Mathematics Concepts" has a secondary loading on the "Reading" factor. "Word Knowledge," "Reading," "Spelling," and "Language" loaded on Factor I, "Reading." "Mathematics Computation," "Mathematics Problem Solving," and "Mathematics Concepts" loaded on Factor II, "Mathematics." On the whole, Reading is the dominant factor, having moderate loadings for two of the three mathematics subtests. Perhaps for an older age group of students in a higher grade (Junior High), the contribution of reading proficiency to mathematics achievement would be reduced.

Factor analysis is a method of measuring construct validity. The inclusion of the "Reading and Mathematics Composite" scores, implies that the "Word Knowledge" and the "Reading" subtests are measuring related traits, while "Mathematics Computation," "Mathematics Concepts," and "Mathematics Problem Solving" measure related traits. The "Language" and "Spelling" subtests, not being part of either composite, supposedly measure separate traits. However, factor analysis of the data from this study would indicate that consideration might be given to including the "Spelling" and "Language" subtests within the "Reading Composite" score. These two tests load fairly heavily on the "Reading" factor, and possibly combine with the other two reading subtests, "Word Knowledge" and "Reading," to measure a more general trait of operational verbal-reading ability.

Results of Factor Analyses Exploring the Relationship Among the Seven MAT Subtests and the Marker Tests

Previous research has shown that achievement loads on a separate, independent factor from either successive processing or simultaneous processing. Table 37 presents a comparison of mean and standard deviation scores, and factor loadings of school achievement. It can be seen from this table that numerous reading and mathematics tests are included. It has been shown in the previous section that reading and mathematics load on independent factors. This finding is consistent with those of Krywaniuk (1974), who had used different achievement tests. On the basis of findings from previous research, it was expected that reading and mathematics would load on separate, independent factors, both from each other and from successive and simultaneous processing.

In the present study, five factors emerged at pretest (refer to Table 38). Factor I, identified as Reading, has high loadings from Schonell, "Word Knowledge," "Reading," "Spelling," and "Language," a high secondary loading from "Mathematics Concepts," and a minor loading from "Mathematics Problem Solving." Factor II, identified as

Table 37

Comparison of Means, Standard Deviations, and Factor Loadings of Academic Tests and Successive and Simultaneous Tests

Authors	Groups	Academic Tests	Means	SD	Factor Loadings
Das, 1973b	Gr. 4 (Edmonton; N=60; High & Low SES)	Reading Achiev.	-	-	.851[a]
		Math. Achiev.	-	-	.844[a]
Krywaniuk, 1974	Low Achievers-Gr. 3 (Edmonton; n=56)	Gates MacGinitie			
		Vocabulary	30.46	5.67	.767[b]
		Comprehension	24.02	6.09	.735[b]
		Spelling	34.04	5.84	.768[b]
		Arithmetic	38.89	10.28	.480[c]
		Stanford Achiev.			
		Word Meaning	21.09	5.16	.768[d]
		Paragr. Meaning	30.63	6.86	.654[b]
		Word St. Skills	41.96	9.82	.772[b]

[a] School Achievement Factor Loading

[b] Reading Factor Loading

[c] Mathematics Factor Loading

[d] "Word Meaning" Factor Loading

Table 37 (Cont.)

Comparison of Means, Standard Deviations, and Factor Loadings of Academic Tests and Successive and Simultaneous Tests

Authors	Groups	Academic Tests	Means	SD	Factor Loadings
Krywaniuk, 1974	High Achievers-Gr. 3 (Edmonton; n=56)				
		Gates MacGinitie			
		Vocabulary	40.93	5.03	$.650^b$
		Comprehension	36.29	9.61	$.727^b$
		Spelling	46.00	8.50	$.846^b$
		Arithmetic	48.85	7.14	$.814^c$
		Stanford Achiev.			
		Word Meaning	26.36	4.59	$.676^d$
		Paragr. Meaning	44.45	8.44	$.602^b$
		Word St. Skills	52.57	8.35	$.652^c$
Das & Molloy, 1975	Low IQ (Males, Gr. 4; n=60; High & Low SES)				
		Reading Achiev.			
		Vocabulary	-	-	$.878^b$
		Comprehension	-	-	$.650^b$

Table 38

Principal Components Analysis with Varimax Rotation of the Metropolitan Achievement Test Subtest (Raw Scores) Scores (Excluding Reading and Mathematics Composite Scores) and the Marker Tests at Pre-Test

(N=68)

VARIABLES	Reading	Successive	Mathematics	Simultaneous	Span	h^2
RAVEN'S MATRICES	-.009	.092	-.013	-.782	-.365	.754
MEMORY FOR DESIGNS	-.030	-.207	.124	.771	-.132	.670
SERIAL RECALL	.046	.826	.181	-.093	.317	.826
FREE RECALL	.051	.853	.089	-.071	.268	.814
DIGIT SPAN-FORWARD	.146	.290	.014	-.009	.796	.739
COLOR NAMING	-.208	-.681	-.264	.015	.239	.635
BENDER GESTALT	-.027	.362	-.278	.651	-.309	.728
SCHONELL	.825	.086	.092	-.031	.219	.745
WORD KNOWLEDGE	.903	.096	-.036	-.092	.114	.847
READING	.870	.154	.055	.085	.050	.793
LANGUAGE	.739	.089	.217	-.086	-.204	.650
SPELLING	.800	-.122	.282	.046	.046	.739
MATH. COMPUT.	.033	.139	.899	-.045	-.092	.839
MATH. CONCEPTS	.529	.291	.598	.063	-.013	.726
MATH. PROB. SOLV.	.361	.224	.711	.058	.245	.749
Variance	3.921	2.357	2.013	1.680	1.286	11.257

Successive Processing, has high loadings from Serial Recall, Free Recall, Digit Span-Forward, and Color Naming, and a minor loading from Bender Gestalt. Color Naming is a latency measure which is reflected by the negative sign. Factor III, identified as Mathematics, has high loadings from "Mathematics Computation," "Mathematics Concepts," and "Mathematics Problem Solving." Factor IV, identified as Simultaneous Processing, has high loadings from Raven's Coloured Progressive Matrices, Memory For Designs, and Bender Gestalt. Memory For Designs is an error score and the negative sign on Raven's Coloured Progressive Matrices reflects the opposite of this. Factor V, identified as a Span factor, has a high loading from Digit Span-Forward and a slight negative loading from Raven's Coloured Progressive Matrices. (Factor loadings on the pre- test composite analysis were similar to loadings for pre- test analyses on the marker tests and MAT, respectively (Chapter VII and Chapter X, section i).

In the above analysis, the intention was to investigate the relationship between achievement, as measured by the MAT, and cognitive skills, as measured by the marker tests. The analysis showed that the successive and simultaneous processing factors and the reading and mathematics factors were independent, with little overlap of factor loadings between the MAT and the marker tests.

However, it is perhaps not very informative to combine the achievement tests and the marker tests, and carry out a factor analysis. An alternate and more informative method is to compute successive and simultaneous factor scores as has been done in Chapter IX, then to compute correlations between the achievement tests and factor scores for the two modes of information processing. Table 39 presents correlations between successive and simultaneous factor scores and the MAT subtests. Correlations are derived from pre- test raw scores, since the effects of intervention would confound post- test results, which include both the Experimental and Control groups. At post-test, a consideration of the factor analysis based on just the Experimental or the Control group would not be warranted as the samples would be far too small.

Table 39 indicates that some of the MAT subtests correlate significantly in a rather scrambled manner with the two factor scores. "Spelling" and "Mathematics Problem Solving" correlate significantly with just the simultaneous factor, while "Mathematics Computation" correlates significantly with just the successive factor. "Mathematics Concepts" and the "Mathematics Composite" correlate significantly with both the successive and simultaneous factors. The fact that all subtests did not show a significant correlation with either the successive or simultaneous factor

Table 39

Correlations Between Successive and Simultaneous Factor Scores and the Metropolitan Achievement Test Subtests at Pre- Test

(N=68)

SUBTESTS	Successive Factor Scores	Simultaneous Factor Scores
WORD KNOWLEDGE	-.133	.143
READING	.060	.168
READING COMPOSITE	-.108	.163
LANGUAGE	.236	.103
SPELLING	-.186	.281[a]
MATH. COMPUT.	-.352[b]	.126
MATH. CONCEPTS	-.253[a]	.307[a]
MATH. PROB. SOLV.	.085	.303[a]
MATH. COMPOSITE	-.270[a]	.292[a]

[a] P<.05

[b] P<.01

may have been a result of having to combine, for the purpose of factor analysis, children who were achieving at different academic levels. Cummins and Das (1977) in reviewing related research noted that while successive processing is strongly related to reading achievement in children experiencing reading difficulty, simultaneous processing is more likely to be involved at more competent stages of reading. These effects may have counterbalanced each other in the case of the MAT reading subtests.

Results from these analyses must be regarded with some caution. Principal components analysis should ideally have a sample size of at least 100 (Gorsuch, 1974). However, results are suggestive and tend to confirm findings from previous research.

CHAPTER XI

THE EFFECTS OF REMEDIAL INTERVENTION ON ACADEMIC ACHIEVEMENT: A TEST OF HYPOTHESIS 4

HYPOTHESIS 4: Improvement in academic performance on the Metropolitan Achievement Test after intervention will be greater for the Experimental group than for the Control group.

The question asked by this hypothesis is whether non-academic intervention will transfer to academic tasks in order to facilitate academic performance. In previous chapters it was shown that children experiencing academic difficulties are deficient in sequential processing skills. Krywaniuk (1974) demonstrated that training in the verbal-successive strategy facilitated performance in word recognition. Hays and Pireira (1972) found training in visual and auditory memory facilitated reading achievement. It has been shown (in Chapter VIII) that intervention in the present study improved cognitive performance. This chapter will examine the effects of intervention on academic performance.

The data in this section are based on all 68 subjects. Pre- and post- test means and standard deviations for the nine MAT subtests in raw scores have been presented in Table 35 (refer to Chapter X). The means and standard deviations for the Experimental and Control groups at both pre- and post- test are presented separately in Table 40. Table 41 presents, for each of the four groups used in the present study (n=17), the means and standard deviations for the nine subtests at both pre- and post- test.

Discussion of Pre- to Post- Improvement: Analyses of Variance

Analyses of variance were calculated separately for each of the MAT subtests using a three-factor design with repeated measures on the last factor (Winer, 1962). The factors were: Experimental/Control; "Average"/"Below Average"; and Pre-/Post-Test Scores.

A summary of the analyses computed for this section is presented in Table 42; however, complete summary tables for each analysis will be presented with the discussion for that subtest. On all subtests the overall performance of the "Average" group was significantly greater than the overall performance of the "Below Average" group. A t-test for independent means was calculated for each subtest, using pre- and post- test means for both groups, in order to determine the significance of difference at both pre- and post- test. A summary of these analyses is presented in Table 43. At both pre- and post- test, for each subtest, performance of the "Average" group was significantly

Table 40

Means and Standard Deviations for the Metropolitan Achievement Test (Raw Scores) for the Experimental Group and the Control Group at Both Pre- and Post- Test

EXPERIMENTAL GROUP

	Pre-		Post-	
SUBTESTS	Mean	SD	Mean	SD
WORD KNOWLEDGE	34.38	9.28	38.47	8.40
READING	25.18	6.19	29.44	5.25
READING COMPOSITE	59.55	9.84	67.91	10.47
LANGUAGE	24.26	7.81	29.18	7.60
SPELLING	26.24	9.72	32.74	7.68
MATH. COMPUT.	19.29	4.59	28.35	6.75
MATH. CONCEPTS	20.12	5.80	26.21	5.45
MATH. PROB. SOLV.	17.71	5.53	21.88	6.63
MATH. COMPOSITE	57.38	8.47	76.44	11.63

CONTROL GROUP

	Pre-		Post-	
SUBTESTS	Mean	SD	Mean	SD
WORD KNOWLEDGE	36.26	8.74	39.47	5.61
READING	25.56	7.19	28.53	7.04
READING COMPOSITE	61.82	11.58	73.00	9.26
LANGUAGE	27.97	7.65	31.24	9.47
SPELLING	26.76	8.52	32.29	6.04
MATH. COMPUT.	20.59	6.23	27.91	5.72
MATH. CONCEPTS	21.71	6.04	24.44	5.67
MATH. PROB. SOLV.	19.50	5.64	21.62	5.35
MATH. COMPOSITE	61.79	9.95	73.97	11.56

Table 41

Means and Standard Deviations for the Metropolitan Achievement Test Subtest (Raw Score) Scores, at Both Pre- and Post- Test, for Each of the Four Groups Used in the Present Study

	EXPERIMENTAL "AVERAGE"				CONTROL "AVERAGE"			
	Pre-		Post-		Pre-		Post-	
SUBTESTS	Mean	SD	Mean	SD	Mean	SD	Mean	SD
WORD KNOWLEDGE	40.35	3.81	42.82	4.90	41.35	4.91	42.12	3.76
READING	29.41	3.84	31.94	4.51	29.94	5.21	31.47	5.44
READING COMPOSITE	69.76	6.34	74.76	8.25	71.29	9.38	73.59	7.10
LANGUAGE	29.65	5.21	34.41	5.53	32.12	4.39	35.65	6.71
SPELLING	31.76	6.75	36.71	3.27	31.35	7.58	35.00	4.64
MATH. COMPUT.	21.71	4.16	31.12	4.12	23.82	5.03	30.23	3.73
MATH. CONCEPTS	24.47	3.91	29.47	4.03	25.76	3.67	27.94	4.39
MATH. PROB. SOLV.	21.41	4.60	26.82	3.36	23.76	3.58	24.12	3.89
MATH. COMPOSITE	67.59	8.34	87.41	8.31	73.35	9.45	82.29	9.36

	EXP. "BELOW AVERAGE"				CONT. "BELOW AVERAGE"			
	Pre-		Post-		Pre-		Post-	
SUBTESTS	Mean	SD	Mean	SD	Mean	SD	Mean	SD
WORD KNOWLEDGE	28.41	9.35	34.12	9.02	31.18	8.85	36.82	5.99
READING	20.94	5.10	26.94	4.83	21.18	6.22	25.59	7.36
READING COMPOSITE	49.35	13.35	61.06	12.69	52.35	13.78	62.41	11.42
LANGUAGE	18.88	6.09	23.94	5.50	23.82	8.06	26.82	9.93
SPELLING	20.71	9.18	28.76	8.81	22.18	6.88	29.59	6.18
MATH. COMPUT.	16.88	3.71	25.59	7.80	17.35	5.70	25.59	6.48
MATH. CONCEPTS	15.76	3.73	22.94	4.72	17.65	5.17	20.94	4.59
MATH. PROB. SOLV.	14.41	3.98	16.94	5.25	15.23	3.77	19.12	5.54
MATH. COMPOSITE	47.18	8.60	65.47	14.96	50.23	10.45	65.65	13.76

Table 42

Summary of Analyses for Metropolitan Achievement Test Subtests (Raw Scores)
Three-Way Analyses of Variance with One Factor Repeated

	SOURCE (Expressed as Calculated F-Ratio)						
SUBTESTS	A(EXP/CONT)	B("AV"/"BELOW AV")	AB	PRE/POST	AC	BC	ABC
WORD KNOWLEDGE	-	35.98^{c}	-	35.02^{c}	-	10.85^{b}	-
READING	-	41.56^{c}	-	24.61^{c}	-	4.74^{a}	-
READING COMPOSITE	-	47.19^{c}	-	44.02^{c}	-	10.92^{b}	
LANGUAGE	4.36^{a}	48.26^{c}	-	24.18^{c}	-	-	-
SPELLING	-	28.61^{c}	-	103.18^{c}	-	8.45^{b}	-
MATH. COMPUT.	-	21.34^{c}	-	12.20^{c}	4.41^{a}	-	-
MATH. CONCEPTS	-	87.80^{c}	-	44.76^{c}	6.45^{a}	-	-
MATH. PROB. SOLV.	-	87.70^{c}	-	21.34^{c}	-	-	5.92^{a}
MATH. COMPOSITE	-	98.76^{c}	-	100.19^{c}	4.86^{a}	-	-

a: $P<.05$
b: $P<.01$
c: $P<.001$

Table 43

Summary of t-Tests for Differences Between Pre- and Post-Test Means of "Average" and "Below Average" Groupings

"AVERAGE"

SUBTESTS	Pre-		Post-	
	Mean	SD	Mean	SD
WORD KNOWLEDGE	40.85[a]	4.29	42.47[a]	4.25
READING	29.68[a]	4.45	31.71[a]	4.85
READING COMPOSITE	70.53[b]	7.80	74.18[b]	7.49
LANGUAGE	30.88[c]	4.83	35.03[c]	6.00
SPELLING	31.56[c]	6.97	35.83[c]	3.99
MATH. COMPUT.	22.76[c]	4.60	30.68[c]	3.84
MATH. CONCEPTS	25.12[c]	3.73	28.71[c]	4.16
MATH. PROB. SOLV.	22.59[b]	4.17	25.47[b]	3.77
MATH. COMPOSITE	70.47[c]	9.11	84.85[c]	8.96

"BELOW AVERAGE"

SUBTESTS	Pre-		Post-	
	Mean	SD	Mean	SD
WORD KNOWLEDGE	29.79[c]	8.94	35.47[c]	7.55
READING	21.06[c]	5.52	26.26[c]	6.07
READING COMPOSITE	50.85[c]	13.25	61.73[c]	11.73
LANGUAGE	21.35[b]	7.36	25.38[b]	7.92
SPELLING	21.44[c]	7.91	29.18[c]	7.39
MATH. COMPUT.	17.12[c]	4.67	25.59[c]	6.96
MATH. CONCEPTS	16.71[c]	4.48	21.94[c]	4.63
MATH. PROB. SOLV.	14.82[b]	3.78	18.03[b]	5.38
MATH. COMPOSITE	48.71[c]	9.41	65.56[c]	13.94

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a: $P<.05$

b: $P<.01$

c: $P<.001$

greater than that of the "Below Average" group. The difference at pre- test was expected on the basis of the cursory analyses, detailed in Chapter III, computed in order to establish the significant difference between these two groups. Thus, while the "Below Average" group was essentially a lower extension of the "Average" group, the "Average" group was composed of enough children in the upper ranges of the "average" limits so that differences at both pre- and post- test were significantly different.

On all subtests, there was a significant pre/post improvement in scores. This finding was expected as the result of usual academic growth throughout the school year. Since the "Average"/"Below Average" and Pre/Post differences were both consistently significant for all subtests, and since these results were expected from the raw score data, these results will not be discussed in the separate discussion for each subtest.

1. Word Knowledge

The summary of the analysis for "Word Knowledge" is presented in Table 44. The analysis indicates that the "Av"/"BAv" X Pre/Post interaction was significant. While both the "Average" and "Below Average" groups showed improvement between pre- and post- test, improvement was significantly greater for the "Below Average" group.

Table 44

Three-Way Analysis of Variance with One Factor Repeated for Word Knowledge

SOURCE	SS	DF	MS	F	P
Bet Subj	7830.06	67			
A (Exp/Cont)	70.56	1	70.56	.92	-
B ("Av"/"BAv")	2772.00	1	2722.00	35.98	.001
AB	57.00	1	57.00	.74	-
Subj w grp	4930.50	64	77.04		
Within Subj	1431.00	68			
C (Pre/Post)	452.19	1	452.19	35.02	.001
AC	6.69	1	6.69	.52	-
BC	140.06	1	140.06	10.85	.01
ABC	5.69	1	5.69	.44	-
C X Subj w grp	826.37	64	12.91		

2. Reading

The summary of the analysis for "Reading" is presented in Table 45. The analysis indicates that the "Av"/"BAv" X Pre/Post interaction was significant. While both the "Average" and "Below Average" groups showed improvement between pre- and post- test, improvement was significantly greater for the "Below Average" group.

3. Reading Composite

The summary of the analysis for "Reading Composite" is presented in Table 46. The analysis indicates that the "Av"/"BAv" X Pre/Post interaction was significant. While both the "Average" and "Below Average" groups showed improvement between pre- and post- test, improvement was significantly greater for the "Below Average" group. Since the "Reading Composite" score is derived from the summation of raw scores from "Word Knowledge" and "Reading," these results would logically follow from results of the previous analyses.

4. Language

The summary of the analysis for "Language" is presented in Table 47. The analysis indicates that the Exp/Cont main effect was significant. The overall performance of the Experimental group was significantly lower than that of the Control group.

Table 45

Three-Way Analysis of Variance with One Factor Repeated for Reading

SOURCE	SS	DF	MS	F	P
Bet Subj	4272.81	67			
A (Exp/Cont)	2.37	1	2.37	.06	-
B ("Av"/"BAv")	1680.06	1	1680.06	41.56	.001
AB	2.94	1	2.94	.07	-
Subj w grp	2587.44	64	40.43		
Within Subj	1703.00	68			
C (Pre/Post)	445.00	1	445.00	24.61	.001
AC	14.25	1	14.25	.79	-
BC	85.75	1	85.75	4.74	.05
ABC	.69	1	.69	.04	-
C X Subj w grp	1157.31	64	18.08		

Table 46

Three-Way Analysis of Variance with One Factor Repeated for Reading Composite

SOURCE	SS	DF	MS	F	P
Bet Subj	20740.81	67			
A (Exp/Cont)	46.94	1	46.94	.25	-
B ("Av"/"BAv")	8768.12	1	8768.12	47.19	.001
AB	33.75	1	33.75	.18	-
Subj w grp	11892.00	64	185.81		
Within Subj	4891.00	68			
C (Pre/Post)	1794.25	1	1794.25	44.02	.001
AC	40.12	1	40.12	.98	-
BC	445.06	1	445.06	10.92	.01
ABC	3.69	1	3.69	.09	-
C X Subj w grp	2608.62	64	40.76		

Table 47

Three-Way Analysis of Variance with One Factor Repeated for Language

SOURCE	SS	DF	MS	F	P
Bet Subj	7589.50	67			
A (Exp/Cont)	282.50	1	282.50	4.36	.05
B ("Av"/"BAv")	3125.81	1	3125.81	48.26	.001
AB	36.00	1	36.00	.56	-
Subj w grp	4145.19	64	64.77		
Within Subj	2097.00	68			
C (Pre/Post)	568.31	1	568.31	24.18	.001
AC	23.00	1	23.00	.98	-
BC	.06	1	.06	.00	-
ABC	1.50	1	1.50	.06	-
C X Subj w grp	1504.12	64	23.50		

5. Spelling

The summary of the analysis for "Spelling" is presented in Table 48. The analysis indicates that the "Av"/"BAv" X Pre/Post interaction was significant. While both the "Average" and "Below Average" groups showed improvement between pre- and post- test, improvement was significantly greater for the "Below Average" group.

6. Mathematics Computation

The summary of the analysis for "Mathematics Computation" is presented in Table 49. The analysis indicates that the Exp/Cont X Pre/Post interaction was significant. While both groups showed improvement between pre- and post-test, improvement for the Experimental group was significantly greater than improvement for the Control group.

7. Mathematics Concepts

The summary of the analysis for "Mathematics Concepts" is presented in Table 50. The Exp/Cont X Pre/Post interaction was significant. While both groups showed improvement between pre- and post- test, improvement for the Experimental group was significantly greater than improvement for the Control group.

8. Mathematics Problem Solving

The summary of the analysis for "Mathematics Problem Solving" is presented in Table 51. The Exp/Cont X "Av"/"BAv" X Pre/Post interaction was significant. The effect

Table 48

Three-Way Analysis of Variance with One Factor Repeated for Spelling

SOURCE	SS	DF	MS	F	P
Bet Subj	7801.50	67			
A (Exp/Cont)	.06	1	.06	.00	-
B ("Av"/"BAv")	2397.31	1	2397.31	28.61	.001
AB	41.37	1	41.37	.49	-
Subj w grp	5362.75	64	83.79		
Within Subj	2102.50	68			
C (Pre/Post)	1230.00	1	1230.00	103.18	.001
AC	8.00	1	8.00	.67	-
BC	100.69	1	100.69	8.45	.01
ABC	.87	1	.87	.07	-
C X Subj w grp	762.94	64	11.92		

Table 49

Three-Way Analysis of Variance with One Factor Repeated for Mathematics Computations

SOURCE	SS	DF	MS	F	P
Bet Subj	4509.36	67			
A (Exp/Cont)	6.36	1	6.36	.12	-
B ("Av"/"BAv")	1125.13	1	1125.13	21.34	.001
AB	3.91	1	3.91	.07	-
Subj w grp	3373.95	64	52.71		
Within Subj	1995.85	68			
C (Pre/Post)	298.36	1	298.36	12.20	.001
AC	107.86	1	107.86	4.41	.05
BC	5.06	1	5.06	.21	-
ABC	19.54	1	19.54	.80	-
C X Subj w grp	1565.03	64	24.45		

Table 50

Three-Way Analysis of Variance with One Factor Repeated for Mathematics Concepts

SOURCE	SS	DF	MS	F	P
Bet Subj	3385.12	67			
A (Exp/Cont)	.25	1	.25	.01	-
B ("Av"/"BAv")	1957.75	1	1957.75	87.80	.001
AB	.06	1	.06	.00	-
Subj w grp	1427.06	64	22.30		
Within Subj	1729.00	68			
C (Pre/Post)	661.75	1	661.75	44.76	.001
AC	95.56	1	95.56	6.46	.05
BC	23.06	1	23.06	1.56	-
ABC	2.37	1	2.37	.16	-
C X Subj w grp	946.25	64	14.78		

Table 51

Three-Way Analysis of Variance with One Factor Repeated for Mathematics Problem Solving

SOURCE	SS	DF	MS	F	P
Bet Subj	3438.44	67			
A (Exp/Cont)	14.89	1	14.89	.66	-
B ("Av"/"BAv")	1965.36	1	1965.36	87.70	.001
AB	23.89	1	23.89	1.07	-
Subj w grp	1434.30	64	22.41		
Within Subj	1377.50	68			
C (Pre/Post)	315.07	1	315.07	21.34	.001
AC	29.18	1	29.18	1.98	-
BC	.89	1	.89	.06	-
ABC	87.38	1	87.38	5.92	.05
C X Subj w grp	945.00	64	14.77		

of intervention on the degree of change is dependent upon the "Av"/"BAv" subgrouping within the Exp/Cont grouping. Thus, pre/post improvement in performance was significant for the Experimental "Average" group and the Control "Below Average" group, while improvement for the Experimental "Below Average" and the Control "Average" groups was not significant.

9. Mathematics Composite

The summary of the analysis for "Mathematics Composite" is presented in Table 52. The Exp/Cont X Pre/Post interaction was significant. While both groups improved in performance between pre- and post- test, improvement for the Experimental group was significantly greater than improvement for the Control group. Since the "Mathematics Composite" score is derived from the summation of raw scores from "Mathematics Computation," "Mathematics Concepts," and "Mathematics Problem Solving," these results would logically follow from the results of the previous analyses.

Inspection of the means for the four groups at both pre- and post- test indicated that in all subtests except "Spelling" for the Experimental "Average" group, pre- test scores for the Control group were higher than pre- test scores for the Experimental group (refer to Table 41). These differences in pre- test scores were not significant.

Table 52

Three-Way Analysis of Variance with One Factor Repeated for Mathematics Composite

SOURCE	SS	DF	MS	F	P
Bet Subj	23661.62	67			
A (Exp/Cont)	32.00	1	32.00	.22	-
B ("Av"/"BAv")	14329.44	1	14329.44	98.76	.001
AB	14.12	1	14.12	.10	-
Subj w grp	9286.06	64	145.09		
Within Subj	14181.00	68			
C (Pre/Post)	8292.94	1	8292.94	100.19	.001
AC	402.62	1	402.62	4.86	.05
BC	51.50	1	51.50	.62	-
ABC	137.12	1	137.12	1.66	-
C X Subj w grp	5297.25	64	82.77		

However, at post- test, subtest scores were higher for the Experimental group than for the Control group with the exception of "Language" for both the Experimental "Average" and Experimental "Below Average" groups, and "Word Knowledge," "Reading Composite," "Spelling," "Mathematics Problem Solving," and "Mathematics Composite" for the Experimental "Below Average" group. These differences in post- test scores were not significant except for the "Mathematics Problem Solving" subtest where the Experimental "Average" score was significantly greater than the Control "Average" score.

Thus, while results were not significant, inspection of the data reveals a definite trend toward greater improvement between pre- and post- test for the Experimental groups. Possibly, had the Experimental and Control groups been more nearly equal in pre- test subtest scores, changes between pre- and post- test performance would have been significant.

Summary

In order to test Hypothesis 4, a three-way analysis of variance with repeated measures on one factor was calculated for each of the nine MAT subtests. These analyses indicated that the improvement in the performance of the Experimental group was significantly greater than the improvement in performance of the Control group for "Mathematics

Computation," "Mathematics Concepts," and "Mathematics Composite." The fact that significant differences in improvement were not revealed for the other six subtests means that Hypothesis 4 cannot be accepted. However, since intervention stressed mainly the use of successive strategies, the hypothesis may have been too encompassing in including all of the MAT subtests. In Chapter IX which presented factor analyses of MAT subtest scores, the factor which received high loadings from mainly the mathematics subtests was identified as "Mathematics." However, inspection of the subtests indicates that they may require manipulation and/or sequential ordering of concepts. The results under present discussion would suggest that these subtests do, at least to some degree, require sequential ordering and manipulation. Eakin and Douglas (1971) had suggested that success in arithmetic relies on automatized sequential computational habits.

The finding that intervention stressing the use of successive strategies did not improve scores on the MAT "Word Knowledge" and "Reading" subtests can also be partially explained by examining the content of these tests. "Word Knowledge" is essentially a measure of the child's comprehension of word meaning. Cummins and Das (1977) have shown that the reading subtest of the Wide Range Achievement Test correlates significantly with successive processing. However, that subtest is a test of word recognition, similar in nature to the Schonell Graded Word List. It was shown in Chapter VIII that intervention in the present study did significantly improve performance on the Schonell Graded Word List. The "Reading" subtest of the MAT requires the child to read and understand whole paragraphs. Guthrie and Goldberg (1972) found a significant correlation between the Benton Visual Retention Test (BVRT) (Benton, 1955) and the "Reading" subtest of the MAT. The BVRT is highly similar to the Memory For Designs test used in the present study. Factor analyses incorporating the Memory For Designs test have shown it to consistently load on the simultaneous factor. Cummins and Das (1977) pointed out that simultaneous processing may be more important in the development of comprehension skills. While competence in reading achievement is strongly related to competence in successive processing skills, it may be that in the present study, the children had not had sufficient practice in using these skills in an academic situation. Thus, for example, word recognition skills had not become automatized enough to permit the ability to use simultaneous processing skills in comprehension of the material read.

The relationship between each individual's pre/post performance on the eight marker tests and his pre/post performance on reading and on mathematics was also investigated. Since the "Reading Composite" score of the MAT is a summation of the two reading subtest raw scores, and the "Mathematics Composite" score is a summation of the three mathematics subtest raw scores, these two composite scores were used in computations. Using raw scores from the entire sample (N=68), the median change for each of the eight marker tests and the "Reading Composite" and "Mathematics Composite" subtests of the MAT were determined by subtracting the pre- test median score (N=68) from the post- test median score (N=68). This resulted in a median change score for the entire sample for each of the eight marker tests and the "Reading Composite" and "Mathematics Composite" subtests of the MAT.

Subsequently, each child's pre- test raw score was subtracted from his post- test raw score for each of the eight marker tests and the "Reading Composite" and "Mathematics Composite." The pre/post change scores of the eight marker tests and two MAT composite subtests for each child were compared to the median change scores. A note was made if the child's change score was above, equal to, or below the change score for the entire sample. By this procedure, it was possible to determine the nature of the relationship between improvement on a marker test and concomitant improvement in either reading or mathematics. Similarly, it was possible to determine the nature of the relationship between decrement on a marker test and concomitant decrement in either reading or mathematics.

For those children who received training, improvement on marker tests and concomitant improvement in reading as measured by the MAT "Reading Composite" was noted. In general, a trend towards improvement on the marker tests and concomitant improvement in reading was revealed, although statistically significant differences were obtained only for Serial Recall, Free Recall, and Color Naming ($z=3.25$, $P<.001$; $z=2.31$, $P<.05$; $z=2.31$, $P<.05$, respectively). The numbers of children in the Experimental group who improved above the median in both "Reading Composite" AND Serial Recall, Free Recall, and Color Naming were 16, 14, and 15, respectively; the comparable numbers of children in the Control group were 3, 4, and 5, respectively. For those children who did not receive training, decrement on marker tests and concomitant decrement in reading was noted. In general, a trend towards decrement on the marker tests and concomitant decrement in reading was revealed, although statistically significant differences were obtained only for Memory For Designs, Serial Recall, and Free Recall ($z=-2.54$, $P<.05$; $z=-2.92$, $P<.01$; $z=-2.69$, $P<.01$; respectively). The numbers of children in the Experimental group who showed a decrement below the median in both "Reading Composite" AND Memory For Designs, Serial Recall, and Free Recall were 2, 0, and 0, respectively; the comparable numbers of children in the

Control group were 13, 13, and 12, respectively. Interestingly, the difference in proportions between the Experimental and Control groups was not significant for the Schonell Graded Word List. This finding would substantiate the previously expressed contention that word recognition skills as measured by the Schonell, while showing improvement for the Experimental group, had not had time to become automatized to the degree where they resulted in a significant change in reading comprehension skills.

For those children who received training, improvement on marker tests and concomitant improvement in mathematics as measured by the MAT "Mathematics Composite" was noted. In general, a trend towards improvement on the marker tests and concomitant improvement in mathematics was revealed, although statistically significant differences were obtained only for Memory For Designs, Serial Recall, Free Recall, Digit Span-Forward, Color Naming, and Bender Gestalt ($z=2.31$, $P<.05$; $z=3.50$, $P<.001$; $z=3.25$, $P<.001$; $z=2.69$, $P<.01$; $z=3.50$, $P<.001$; $z=2.31$, $P<.05$; respectively). The numbers of children in the Experimental group who improved above the median in both "Mathematics Composite" AND Memory For Designs, Serial Recall, Free Recall, Digit Span-Forward, Color Naming, and Bender Gestalt were 12, 16, 15, 12, 16, and 12, respectively; the comparable numbers of children in the Control group were 2, 2, 2, 0, 2, and 2, respectively. For those children who did not receive training, decrement on marker tests and concomitant decrement in mathematics was noted. In general, a trend towards decrement on the marker tests and concomitant decrement in mathematics was revealed, although statistically significant differences were obtained only for Memory For Designs, Serial Recall, Free Recall, Color Naming, Bender Gestalt, and Schonell ($z=-3.25$, $P<.001$; $z=-4.72$, $P<.001$; $z=-3.67$, $P<.001$; $z=-3.42$, $P<.001$; $z=-2.54$, $P<.05$; $z=-2.91$, $P<.01$; respectively). The numbers of children in the Experimental group who showed a decrement below the median in both "Mathematics Composite" AND Memory For Designs, Serial Recall, Free Recall, Color Naming, Bender Gestalt, and Schonell were 3, 0, 3, 4, 3, and 10, respectively; the comparable numbers of children in the Control group were 16, 18, 18, 18, 14, and 21, respectively.

One other interesting finding is that those subtests which showed significant greater pre/post improvement for the Experimental group than for the Control group, i.e., "Mathematics Computation," "Mathematics Concepts," and "Mathematics Composite," were also those which correlated significantly with successive factor scores at pre- test (refer to Chapter X, section ii).

The following conclusions can be drawn from the analyses up to this point: (i) Mathematical skills rely on successive as well as simultaneous processing; (ii) Reading skills, as measured by the Schonell Graded Word List, rely on successive processing; however, skills measured by the MAT reading subtests may rely more on simultaneous processing and the ease (speed) with which word attack skills are employed; (iii) Training in information processing strategies lead to more efficient strategy usage, which, in consequence, improved some academic achievement; and lastly, (iv) The tasks used in intervention in the present study appear to have trained primarily successive strategies.

CHAPTER XII

GENERAL DISCUSSION

It is a rare elementary classroom teacher who is not faced with at least one child who is experiencing considerable difficulty with the academic tasks of his grade level. While many schools today have a "resource room" or a "learning assistance room," the sheer weight of the number of children requiring special help and the perceived need for small groups within the resource room setting mean that many children are left to cope as best they can within the regular classroom without the benefit of special help. Often, the perceptive classroom teacher provides as much individual help as is possible with 20 to 30 other children to teach. However, such help is frequently of a "more of the same" nature (D'Annunzio and Steg, 1974), i.e., repetition and drill on weaknesses in the academic basics. Conversely, remedial aid within the resource room often focusses on discrete cognitive skills, e.g., auditory discrimination, with little or no training given either in how to integrate separately taught skills or how to transfer these skills to an academic situation (Allington, 1975). The central message of the present study is that training in the use of efficient strategies is much more useful than either repetition of content or focus on discrete skills.

Many teachers are understandably negative toward remedial approaches which rely on concepts and terms with which they are unfamiliar, and which, in their view, have no bearing on academic achievement. Others are somewhat resentful of having to plan for and use material not directly related to academic tasks. What is needed is a remedial approach which could fit into the regular classroom routine and which could be applied in varying degrees to the whole class. A program such as this would admittedly not remediate more severe learning problems, which would still require additional, but consistent and related, resource help. However, it would be of considerable benefit to those children whose academic achievement is moderately below their expected grade level.

Adelman and Taylor (1977) have suggested that most children begin school with the ability and the desire to learn. However, the extrinsic demands of the school setting frequently diminish the intrinsic motivation of the children. Adelman and Taylor suggested that the value which the child places on the learning situation, and his ability to function in that situation, are critical factors influencing motivation, learning, and performance. Children with learning problems have often learned not to trust their own perception of what is of value, or their ability to effectively attack a task. The child who experiences no difficulty in school has untold opportunities for self-satisfaction in his achievements, and for the satisfaction of knowing that his parents and teachers are pleased with his accomplishments. Conversely, the child who is experiencing academic difficulty is constantly faced with his own frustration and failure, and the frustration and negative reactions of parents and teachers (Lerner, 1971). Lerner further pointed out that the occasional successes experienced by these children may convince the school that their poor achievement is merely a result of poor attitude.

The study by Lovitt and Smith (1972) indicated the value of explicit instructions in producing responses in a learning disabled boy who appeared incapable of making these responses without the instructions. Hallahan and Kauffman (1976) suggested that merely because explicit instructions are a simple and readily available means of eliciting desired behavior from children, they should not be ignored as an extremely effective remedial technique. Lovitt and Smith (1972) suggested that in attempting to change a child's behavior, the first step should be clear and consistent instructions regarding the desired behavior. Further, if the behavior is required over a lengthly period, these instructions should be repeated. Research designed to support the "production deficiency hypothesis" of Flavell et al. (1966) as elaborated by others (e.g., Bingham-Newman and Hooper, 1974; Moely et al., 1969) has shown that while young children can be taught to use processing strategies, they fail to use these strategies once direction has been removed. These findings support the contention that instructions should be repeated if the concomitant behaviors are required over a period of time (Lovitt and Smith, 1972). Freston and Drew (1974) have suggested that, through instructions, the teacher can train the child's ability to use the organization existing in his daily world in order to learn efficient strategies with which to facilitate daily performance. In a similar vein, Meeker (1964), Rohwer (1971), and Tulving (1968) have suggested that teaching learning strategies may be more important than teaching content.

Learning disabled children have been shown to have poor organization and retention skills (e.g., Estes, 1974; Freston and Drew, 1974; Johnson and Myklebust, 1967). Similarly, children experiencing academic difficulties are weak in successive strategy skills (e.g., Badian, 1977; Krywaniuk, 1974; Meier, 1971; Richie and Aten, 1976). It has been pointed out that the learning disabled child may not be aware that he can, and should be developing efficient learning strategies on his own (Torgeson, 1977). While many children enter school with either the readiness for employing efficient strategies, or partially developed learning strategies, some children appear to enter school with poor ability to actively receive information and little idea about WHY they are learning basic facts.

From the preceding discussion, it follows that a viable remedial program would be one which would focus on the usefulness of efficient strategies of learning, with secondary emphasis on learning content as the means of practice for learning these strategies. Thus, the focus would be on training LEARNING strategies within the child rather than on the TEACHING method used. The child would have a reason for learning basic facts, and since the program would focus on efficient use of processing strategies, the child should achieve some success. Most children respond very well to "tricks" (strategies) which facilitate learning but which somehow seem to allow them to "cheat the system."

Results of the present study showed that intervention using nonacademic tasks with the focus being on efficient use of the successive processing strategy not only improved efficient use of the successive processing strategy and performance on nonacademic tasks, but, more importantly, improved academic performance in word recognition and mathematics. The method and the results of intervention in the present study have important implications. Firstly, the directed method of attacking the task and the child's concomitant verbalization of successive strategies is far more important than the actual material used in the tasks. Thus, these same methods should be even more successful in improving academic performance when applied directly to academic material. Secondly, the fact that "average" students improved in performance, although not to the degree to which "below average" students improved, indicates that the techniques can justifiably be applied within the regular classroom, to the benefit of all children, but particularly those who are relatively weak in academic performance. Thirdly, the importance of using training material which is intrinsically interesting has been underscored. Children who experience severe learning problems are often completely "turned off" by all academic material (Meyers and Hammill, 1976). The present tasks and methods were fun and nonthreatening. If these techniques were applied in the resource room using non-academic material in conjunction with the application of the same techniques using academic material in the classroom, the child should see some relationship between his removal from the class for "special help," and the opportunity to apply his new learning strategies to disliked academic tasks. Such continuity in remediation should help to bolster the learning disabled child's self-confidence and to eradicate the frequent stigma of having to go to a resource room.

Previous research has shown that, consistent with the Piagetian formulation, training procedures are most beneficial during transitional stages. In the case of simultaneous procedures, the transitional stage appears to be roughly equivalent to the age of Grade 5 children (e.g., Neimark et al., 1971; Rosner, 1971). The training in those two studies involved grouping of materials for recall, a task which requires simultaneous processing. But training in successive strategies, it seems, can be beneficial before Grade 5. Although no developmental data are available, it would appear that training in the efficient use of successive processing would be most beneficial prior to Grade 5, and preferably as early as possible after the child enters school. In any case, what is called 'sequencing' is a basic skill necessary for the development of reading. For instance, Hartlage (1977) found that auditory sequencing ability was an important factor in developing reading skills in a 6-year old, and visual sequencing ability was an important factor in the reading abilities of 8-year olds. Goldman (1972) suggested that educators must seek the strategies which are most efficient for any given task. It has been shown in the present study that training in the effective use of successive strategies significantly improved performance in word recognition and mathematics computation. These are the basics from which later success in reading and mathematics are built. Thus, successive strategy training in the early grades would logically be of the most benefit.

Estes (1974) and Cronbach (1975) have pointed out the increasing resistance to intelligence testing as a method of predicting academic success. Estes suggested the need to show that intelligence tests are viable methods of indicating areas where remedial focus is needed. Das (1972) has shown that mentally handicapped children process information in different ways. Similarly, Smith, Coleman, Dokecki, and Davis (1977) found that educable mentally handicapped children had a different pattern of cognitive abilities according to Bannatyne's (1974) recategorization of WISC-R scaled scores than did either high IQ or low IQ learning disabled children. The WISC-R has been shown to be an extremely useful psychometric instrument (Rugel, 1974; Sattler, 1974; Smith *et al.*, 1977). Using Bannatyne's (1968) categorization of the WISC, Rugel (1974) found that reading disabled children had highest scores on the Spatial Category, intermediate scores on the Conceptual Category, and lowest scores on the Sequential Category. The three tests which compose the Sequential Category, i.e., Digit Span, Coding and Arithmetic, require strategies similar to those required by successive tests in the successive-simultaneous battery. Interestingly, arithmetic computation, in the present study, correlates with the successive factor (refer to Table 39).

Smith *et al.* (1977) found that for the high IQ and low IQ learning disabled children, Spatial > Conceptual >

Sequential, while for the educable mentally handicapped children, Spatial > Sequential > Conceptual. These findings suggest the usefulness of administering an intelligence test, since children falling within the educable mentally handicapped range of intellectual ability have different cognitive patterns and may require differing emphasis in remediation. Smith et al. (1977) pointed out the need for continued research using both the WISC-R and other cognitive instruments in order to produce a refined and reliable procedure for providing differentiated subdiagnoses of learning disabilities. They also emphasized the need for the identification of internal processes and more effective remedial techniques. The present study has shown the Primary Test Battery of the successive-simultaneous processing model to be a reliable indicator of internal processing strategies. One direction for future research should be in combining the WISC-R and the successive-simultaneous battery in order to provide accurate prediction of children entering school who are at high risk of being academically learning disabled, and who would benefit from training in the use of successive or simultaneous processing strategies.

The above findings are consonant with the approach toward remediation in the present study. The successive-simultaneous model of cognitive processing provided a rationale for designing the intervention tasks, which, as a majority, had a direct influence on the development and use of successive strategies. Improvement in performance on some of the academic tasks which required successive processing was also noticed. In addition, the "below average" students benefitted more from training than did the "average" students. On the whole, the study should encourage future research into the use of specific strategies by academically deficient groups, although all of these strategies may not be subsumed under successive and simultaneous. Probably, processes in concept learning and usage of concepts would be only partly related to successive and simultaneous tasks as currently given in the battery. A general case for the success of a rationally based, rather than an improvised remedial program has been made in this study.

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